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UNIVERSITY EXPANSION

FOLLOWING the reports on university development issued in 1944–45, the Association of University Teachers has published a report on university expansion based on factual inquiries and three years experience of the greatly increased student numbers under the new conditions. The report, which was adopted by the Council of the Association on May 20, 1949, records full agreement with the broad lines of policy and the recommendations of the University Grants Committee's report and of that on university awards. It emphasizes, however, that the universities are concerned with a wider problem than that of increasing the number of students with high academic attainments; they should also seek to expand the volume and improve the quality of teaching and research at all levels, as well as to improve the quantity and quality of research workers. The report accepts the figure of 18,000 as the probable annual intake of students, but agrees with Dr. W. W. Grave that the assessment of 5,000 as requiring no grant is too speculative, and also that it is undesirable that a stated number of grants should be made irrespective of the academic level of the new entrants. The report suggests that the number of grants should vary according to the number of applicants considered suitable; but it is probable that there will be a large enough entry of good quality to justify the provision of more than 11,000 awards.

The Association appears to be satisfied that there is a sufficient reserve of talent for expansion to continue at the present rate, but considers that the 'working party's' report on university awards has not brought out clearly the necessity of awards for students entering a university at a more advanced age. Here again the report endorses Dr. Grave's view as well as his argument that the final selection of such candidates should rest with the universities. It is agreed that the problems raised require further investigation; but the report does not pursue the question further than to observe that the financial value of the grants also requires improvement, so that family considerations do not remain a bar to application. It refers appreciatively to the value of the work of the Hankey Committee, and stresses the need for expansion in the numbers of those with a general degree and the value of men with good second-class degrees.

The report considers in some detail the expansion of studies both in the faculties of arts and in those of science. At present, larger numbers of men and women are applying for admission to the arts faculties than can be accepted, and the report stresses the prime importance of general agreement at least as to the approximate number of students to be admitted. To achieve this it is necessary to have an idea of the purpose to which students will put their studies after leaving the universities. The expansion of numbers reading arts cannot be built on any vague principle of balance with the number of science students, but must depend on some calculation, based on general social and educational needs, which has due regard to the prospects of employment.

The report does not, indeed, suggest that subjects of study are to be chosen only for their vocational use, though it recognizes that important changes of curriculum may be advisable. Its comments on the expansion of studies in the faculties of science are more reserved, for the Hankey Committee reports had not then appeared; although they are based on inquiries covering two-thirds of the science departments of all universities and university colleges in Britain, apart from Oxford, Cambridge and Belfast. These inquiries indicate that in some subjects, such as mathematics, the demand for graduates is appreciably less than double the 1939 output, whereas in biological subjects in general, psychology and geology, more than double the 1939 output is expected to be absorbed. There is room for expansion in the number of students in agriculture, and special stress is laid on the acute shortage of women science teachers in the schools, which is now affecting the numbers of girls entering the science departments in the universities.

The two most important features of the report are, however, its discussion of staffing problems generally and of the expansion of social studies. Apart from accommodation, the practical limit to the rate of expansion is still that of staffing; and the general shortage of qualified staff makes the Association unwilling to support at the present time any proposal to establish several new university institutions which would bring a demand for many administrators and heads of departments. Not only is careful planning required here, but also, to avoid the lowering of standards in existing universities, the academic staff should be increased proportionately with the increase in students, both from the point of teaching and of research. This is true of the faculties of arts as well as of those of science. Besides emphasizing the dependence of a healthy academic life on the active prosecution of advanced studies by the teachers, the report points to the need for more grants for research and postgraduate studies on social and historical problems, on foreign languages and cultures, etc. In respect of science, besides stressing the need for a proper balance between teaching and research, which has b[illegible]ously threatened by the post-war expansion, [illegible]t directs attention to the importance of an [illegible]uate staff of trained laboratory stewards and technicians, which could do something to ease the present strain on lecturers. Comment is also made on the inadequacy of library grants at many universities and the need for increased staff as well as funds.

As regards social studies, the Association supports the view that it is a primary duty of the universities to carry out research in this field. This is much more important than the vocational courses which at present occupy so much of the time of the universities in this field. Here, however, the difficulty of staffing is even more acute, and expansion must wait on the training of the personnel required. Meanwhile, closer co-operation between the universities and the numerous institutes already concerned with social studies is desirable, while a survey of the prospects of employment for graduates in this field is advisable, as well as further consideration of the selection of students for such studies.

Apart from its emphasis on the questions of staff, this report from the Association of University Teachers affords independent support for many of the views generally expressed in the last report of the University Grants Committee. There are, indeed, reservations on salaries: those suggested do not, in fact, ensure the modest standard of living to which the University Grants Committee suggests a university teacher is entitled, nor do they take account of such specific academic needs as the accumulation of a private library, membership of learned societies and foreign travel. Also the report makes no comment on the important recommendation of the 'working party' on university awards regarding a university clearing house. That matter, however, was dealt with more explicitly in the discussion on the selection of students for open scholarships and awards, which took place at the Home Universities Conference on December 18, 1948*. Sir Philip Morris, who opened the discussion, stressed the fact that the 'working party' laid down quite frankly the principle that the right of admission should be vested in the university, and he also stressed the need for variety in the method of award. He then went on to commend a clearing-house system for which the universities themselves should accept responsibility, and was convinced that some machinery of this nature must be found. He hoped that by some such common action or other system of dealing with applicants for a university education, the universities would succeed in ensuring dispersal in place of the present system of allocation through State scholarships, in spite of its efficiency. Sir Philip also urged that, as regards increasing their own scholarships, the universities should take a considerable part in the making of awards if variety is to be maintained; but he laid equal stress on the value of establishing and maintaining even closer relations with the schools.

Lord Chorley, who presided at this discussion, thought that the report of the 'working party' underlined and accepted the views which the Association of University Teachers put forward so long ago as 1944; but he pointed out that, nevertheless, since it would be quite impossible to take into the universities during the next few years all those mentally equipped to benefit by a university career, we cannot avoid the problem of selection, nor, indeed, that of eliminating the unfit at present entering the universities. This, Lord Chorley thought, is the least satisfactory part of the report of the 'working party', due possibly to meagre representation of the universities on the 'working party'. Lord Chorley also indicated his readiness to explore fully the possibilities of such a system as that of the Civil Service Selection Board; but in this, however, he was not followed by Dr. Grave, who said he feared that the clearing-house system for university admissions might thus eventually replace that by the universities themselves. Dr. Grave was also nervous about the large proposed increase in awards by local authorities, and was less confident than Sir Philip Morris that there would be a sufficiently increasing supply of suitable candidates.

* Report of the Proceedings of the 1948 Conference of the Universities of Great Britain and Northern Ireland. Pp. 125. (London: Association of Universities of the British Commonwealth.) 1s.

The most impressive features of the discussion generally were the recognition of the vital importance of maintaining standards, and of ensuring that the only criteria for admission to a university should be the personal merits of the candidate. All the misgivings and differences of opinion about the practicability of a clearing house, of a selection board and of the dangers of local-authority awards as opposed to university awards, all really turn on the views held as to their effect on standards and the exclusion of meritorious candidates through such factors as exceptional competition at a particular university or in a particular locality. Sir Griffith Williams, deputy secretary to the Ministry of Education, said that the Ministry wishes to take full account of the views of the universities in determining policy, and in particular on the matter of the recommendations of the local authorities and the question of allocation. The spirit of his brief intervention throws down a distinct if friendly challenge to the universities for constructive thought on these issues, and the full and swift exploration of any means of providing a satisfactory and generally acceptable solution of the problem of university expansion.

The increased economic stringency which has beset Great Britain since the discussion, with the greater difficulties which will be met in providing new buildings, make it all the more imperative that the question of numbers of students should be handled wisely. In the years ahead the nation will, indeed, have need of all the services which the most promising and ablest minds leaving its schools each year can give; and it can ill afford that any such should not be brought to full fruition. Even less can it afford the waste of university resources on those incapable of profiting by such training, or the depreciation of university standards from whatever cause. Zeal to ensure that neither lack of means nor any other factor closes the door of a university to anyone capable of profiting by it must be matched by zeal to see that the conditions within the university—buildings and equipment, staff and amenities—are such that those admitted enjoy the opportunity of a university life in its truest and finest sense.

PLANT PATHOLOGY

Plant Pathology

By Sir Edwin J. Butler and Dr. S. G. Jones. Pp. xii+979. (London: Macmillan and Co., Ltd., 1949.) 63*s*. net.

THE publication of this outstanding work is an event of no mean importance in the history of plant pathology in Great Britain. Whereas Germany has produced Sorauer's "Handbuch der Pflanzenkrankheiten", Italy Ferraris's "Patologia e Terapia Vegetale", France Arnaud's "Traité de Pathologie végétale" and Viennot-Bourgin's "Les Champignons parasites des Plantes Cultivées", and the United States Heald's "Manual of Plant Diseases", Britain has hitherto made no comparable contribution to the science. For many years students had to rely on Massee's "Diseases of Cultivated Plants and Trees" and Duggar's "Fungous Diseases of Plants", and while in the last two decades valuable English books, including Brooks's "Plant Diseases" and others on various aspects of plant pathology, have appeared, nothing yet published in Great Britain has attempted such a comprehensive and thorough treatment of the subject.

The collaboration of the two authors was indispensable to the work. It would have been humanly impossible for the late Sir Edwin Butler, with his onerous duties as secretary of the Agricultural Research Council, to have written the book single-handed, so plant pathology owes much to Dr. Jones, who induced Sir Edwin to undertake the work with his help. While he was director of the Imperial Mycological Institute, Sir Edwin Butler seriously considered a second edition of his much-prized "Fungi and Disease in Plants"; but the project was abandoned before work on it was started. The present book is on similar lines to the first; but diseases of importance in Great Britain and some from other temperate countries replace diseases found in the tropics. Everyone will share the junior author's regret that Sir Edwin Butler did not live to see the fruit of his labours.

The first part of the work is concerned with general principles and was written mainly by the senior author. It comprises nine chapters, with an appendix on the classification of fungi. It deals with: (1) the nature of disease organisms, (2) the life-histories of parasitic fungi, (3) the parasite in relationship with its host, (4) resistance and susceptibility, (5) the influence of environmental and nutritional conditions on plant diseases, (6) morbid anatomy, (7) the principles of plant disease control, (8) virus diseases, and (9) deficiency diseases. The hand of the master is seen in every chapter, and the thorough manner in which each subject is treated is characteristic of the man. It constitutes an excellent introduction to the detailed discussion of selected diseases which comprises the second part. The chapter on morbid anatomy, a subject of special interest to the senior author, is particularly noteworthy, and that on control gives, *inter alia*, a brief but authoritative account of quarantines that is refreshing to read.

The second part gives detailed accounts of selected diseases, separate chapters being devoted to diseases of the following host groups: cereals, pasture and forage crops, potatoes and root crops, pulse crops, vegetables, fruit, ornamental and other plants, and trees. The treatment throughout is excellent. A short historical introduction is usually followed by a description of symptoms, the causal agent of the disease, its physiological characteristics, life-history, and control; but the method adopted is by no means stereotyped. The information available is presented in a fully assimilated form with copious references to original papers, cited in a bibliography appended to the account of each disease.

In a work of such a high standard it may seem invidious to make any suggestion for improvement; but one could not help wishing that the authors had given a somewhat fuller account of the modern developments in spraying equipment and techniques that have been such a prominent feature of British plant protection in recent years. For example, nothing is said about the standardization of nozzles made possible by the introduction of stainless steel disks, the air-blast type of sprayer, the possibility of low-volume sprays, or the use of helicopters. Disinterested, up-to-date information on the subject is difficult to obtain and would be correspondingly

valuable, though perhaps full treatment would have taken more space than the authors could afford. The control of plant disease is the ultimate objective of all plant-pathological work, and this should never be forgotten, even by the student.

Consideration of space also probably explains the absence of any account of phytopathological technique. This again is changing every day as new methods are devised; but technique is extremely important in research, and the student should beyond all doubt be carefully trained in its methods.

The classification of the fungi set forth in the appendix is a little out of date. The Ancylistales are now the Lagenidiales, the Entomophthorales have three families, *Pseudopeziza*, *Lasiscypha* and *Sclerotinia* are usually placed in the Helotiales and not the Pezizales, and the Uredinales are now divided into only two families. However, no two mycologists are likely to agree in all points about classification, the comparatively chaotic state of which is one of the obstacles to the progress of plant pathology to day.

The illustrations throughout are a feature of the volume. Many are original line drawings by Dr. Jones, and these are beautifully executed. For the selection of published figures he has taken the trouble to go to the original sources. Even though well supplied with illustrations, there is no doubt that coloured plates showing typical deficiency diseases (none is illustrated in Part 1) would have added to the value of the work and that some of the striking photographs of plant viruses by the electron microscope might well have been provided. In a plant-pathological work of this sort it seems a pity to use non-pathogenic fungi for figures when there is such abundant pathological material available for illustration. These are, however, minor blemishes that can easily be remedied in a further edition.

The work is essentially a book for the university student and research worker in plant pathology, though advisory officers and agricultural administrators and even the 'practical man' may find much of interest and profit within its leaves. It will doubtless do much to stimulate interest in plant pathology in Britain and, it is hoped, elsewhere. The student has now an excellent, modern, British text-book to initiate him into the intricacies of the subject, and it is likely that the volume will be a standard work of reference for many years to come. A comprehensive volume such as this probably represents the limit of size that is feasible, and, in future, diseases of particular host groups will probably have to be discussed in separate volumes. Any attempt to make the accounts of diseases of the various hosts complete would swell the book to an impracticable size, and the authors were undoubtedly right in restricting the scope of their work to the more important diseases under the common host attacked. It is satisfactory to note that plant pathology is interpreted as including all disease-producing agents—bacteria, fungi, viruses, soil deficiencies, and physiological disorders, though nothing is said about eelworms, which in Great Britain are usually regarded as a separate subject. The book therefore gives the student a wide outlook—a specially pleasing feature in view of the tendency to over-specialization that can be discerned in some quarters.

There is some evidence that the work has taken a long time to print, and the second author has found it difficult to keep the text up to date. For example, the agent of brown rust of barley is now named *Puccinia hordei*; no reference is made to the noteworthy paper of Risbeth on *Fomes annosus*, or to Nicholas's work on the diagnosis of deficiency diseases by the tissue technique. But, with printing taking as long as it now does, it is inevitable that books should suffer in this way, and it is to be hoped that printers may be able to do something to speed up the publication of scientific work. Apart from this the publishers are to be congratulated on the fine quality of the production. There are few misprints and few slips in the text.

The work is undoubtedly a most valuable contribution to phytopathological literature, not only of Great Britain but also of the world. It is an achievement the full significance of which will probably be revealed only as the years go by. At this juncture, when plant pathologists are so urgently required, it is particularly welcome, and the ripe scholarship and massive learning that have gone into its production will, it is to be hoped, fructify for many generations in the better training of plant pathologists and a correspondingly increased effectiveness in the fight against plant disease.

S. P. Wiltshire

STRUCTURAL GEOLOGY

Principles of Structural Geology

By Prof. Charles Merrick Nevin. Fourth edition. Pp. xiii+410. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 48s. net.

THE new edition of this popular and attractive text-book will be widely welcomed. Much of the detail has been reorganised and re-written, and many new sections and illustrations have been added. The most notable addition is a final chapter on "Laboratory Exercises", a title which somewhat obscures the real utility of the methods described in their application to field work. The principal method discussed is that of orthographic projection. Less space is devoted to the still more powerful weapon of stereographic projection; but the author is to be congratulated on having introduced it into a text-book for the first time. It is to be hoped that his treatment will popularize the application of this projection to the many structural problems which can readily be solved with its aid. Useful exercises in stratum-contouring are also included. In the presentation of structural data, no uniform system has been adopted; adherence to a single convention would doubtless be an improvement. It would also be useful to include a short discussion of the limits of accuracy required in structural measurements; in this book one or two dips are recorded to 30′ without any indication that such 'accuracy' can rarely be justified. The chapter on intrusion tectonics has been effectively re-written by Dr. E. B. Mayo. Here, it may be suggested that a table of map symbols (including, but not confined to, those used in mapping intrusions and plutonic complexes) would be an appropriate addition.

The systematic account of structures is generally sound. The treatment of competent beds is much improved, but the distinction between symmetric and isoclinal folds is less clear than in the first edition. One or two errors call for future correction: for example, fold-closure is not synonymous with dying-out (pp. 41 and 43), and it is quite wrong to state (p. 170) that "the true direction of plunge will

always parallel the strike of the cleavage". Here, and also in the introduction to the stereographic projection method, the value of plunge determinations and their utility might well be elaborated, using the results of Wegmann's work in Finland as a guide and in further illustration. Moreover, it may be remarked that for Lugeon and Argand a nappe is not necessarily based on a thrust; according to Argand, who knew the ground much more intimately than any critic, the reversed limb of the Dent Blanche nappe, though greatly thinned, is never cut out (cf. p. 119). Reference to the Alps suggests the question whether, in a book on structural geology, the Alps should be dismissed in twenty-nine lines while, for example, submarine valleys receive nearly 130.

In the introduction the importance of discrimination between fact and hypothesis is emphasized. Structures can be seen and measured; movements can often be inferred; but knowledge of the active forces is rarely more than hypothetical. Yet the author, very surprisingly, proposes (pp. 48–49) that structural terms should have genetic significance. This implied confusion between description and interpretation is perhaps responsible for his difficulty with over- and under-thrusting (p. 128). Taken as a whole, the standard of the new edition marks a real advance in the presentation of an admittedly difficult subject. A few criticisms have been made, but they are intended to be constructive, and they are offered in the hope that in future editions this excellent book may yet become the leader in its class.

EVOLUTION OF MAN

Early Man

A Survey of Human Origins. By Alan Houghton Brodrick. Pp. 288+13 plates. (London: Hutchinson's Scientific and Technical Publications, 1948.) 18*s*. net.

POPULAR expositions on the subject of early man can roughly be divided into two categories: those of the journalistic type which are little more than dramatized versions of more authoritative accounts, 'written down' for the apparently unintelligent reader; and those which strive to be sober and critical surveys based on a careful study of scientific documents, and, in some cases, of the original evidence. Mr. A. H. Brodrick's book finds its place in the latter category. The author weighs the available evidence (much of it still very meagre) with due care, and presents his conclusions with commendable restraint. Clearly his book is intended for the intelligent reader. But this is not to say that it is written in an unattractively pedagogic style; on the contrary, the story of discovery is presented in the form of a stimulating narrative which flows easily from one item to another, and which conveys (in brief) a vivid impression of the whole field of palæo-anthropology as it stands to-day.

During the past fifteen years or so, discoveries relating to early man have been most remarkable for their abundance; it is therefore very appropriate that a book of this sort should be available which brings the story of human evolution up to date for the general reader. This the author does very effectively, and in his book references will be found to a number of significant discoveries which otherwise have not yet found their way into popular accounts of human evolution. Among such novel features are descriptions and discussions of the Neanderthal remains found in Italy, the palæolithic cave paintings at Lascaux, the relics of *Pithecanthropus* and allied forms found by Dr. von Koenigswald in Java shortly before the Second World War, the Acheulean site at Olorgesailie in Kenya, palæolithic industries in Asia, the Australopithecine fossils of South Africa, the Swanscombe skull fragments, and the neanderthaloid skeleton from Uzbekistan.

But new discoveries proceed apace, and even since this book was published in 1948, still more new finds of great significance have been made. Therefore, since Mr. Broderick's book is, without doubt, one of the best popular expositions of early man now available, it is to be hoped that a new edition will not be long forthcoming.

A HISTORY OF SCIENCE

Science, Past and Present

By Dr. F. Sherwood Taylor. New edition. Pp. x+368+28 plates. (London: William Heinemann, Ltd., 1949.) 12*s*. 6*d*. net.

WE welcome this new edition of the work of the keeper of the Museum of the History of Science in Oxford. Dr. F. Sherwood Taylor's "Science, Past and Present" was first published in 1945 and was immediately reprinted. It is appropriate that it should now be presented in a larger edition and produced in a style worthy of its contents.

The book, in simple yet scientific language, depicts science as a living, growing organism and thereby demonstrates its powers and limitations, and so sets it in its place among the various activities of mankind. Dr. Taylor has in mind the needs of the intelligent layman, the 'sixth form' and the science specialist who wishes to see the place of his limited study in a greater scheme of things. It is pleasing to note that this book is entirely free from the political prejudices and propaganda which mar so many works which deal with the history and social applications of science.

The story of mechanics, physics and chemistry, biology and geology, which is the 'stock in trade' of most writers on the history of science, is enriched by the addition of an account of the development of other parallel studies such as public health, the methods of science and its functions. The author faces the problems of the limitations of science. "Those who remember that scientific laws are summaries of observations and not legal enactments will have no difficulty in discovering the phenomena to which they can safely be applied." One recalls the lines of the poet Walt Whitman in speaking of scientific men:

> "Gentlemen! to you the first honours always:
> Your facts are useful and real—and yet they are not my dwelling;
> (I but enter by them to an area of my dwelling.)"

One of the most useful features of Dr. Sherwood Taylor's book is the way in which he supports each chapter with a set of extracts from contemporary scientific documents. Such material is not easily available in sufficient quantity, and the work under review is a valuable additional source. It remains to be said that there is a good bibliography, that the pictures and diagrams are of first-rate quality and that the book is beautifully produced.

W. L. SUMNER

Aristotle's Prior and Posterior Analytics

A revised Text with Introduction and Commentary by W. D. Ross. Pp. x+690. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 42*s.* net.

IT would be both impertinent and inappropriate to attempt any more than to accord to this monumental work the welcome which its origin and importance make obvious. To this perhaps may be added the gratitude of men of science—in the widest sense—to Sir David Ross for his labours, and no less for the gracious form in which they are presented. One hundred and forty-five years have gone by since the last critical edition of the "Analytics" was published; several studies have appeared during that time. These find their place in the present text, as well as the work of two of the great Renaissance scholars.

The rapid growth of many-valued logics in recent years brings to mind the need for continuous recollection of the rock whence they are hewn; it is not a little remarkable that—in many cases—the savants most creative in progressive researches are just those best versed in the long history of their subject. To them and their like this revised text, introduction and commentary should make its own special appeal.

F. I. G. RAWLINS

Evolution of the Forebrain

The Fundamental Anatomy of the Telencephalon with special reference to that of *Testudo geometrica*. By Dr. G. W. H. Schepers. Pp. xi+212. (Cape Town: Maskew Miller, Ltd.; London: John Clark, 1948.) 50*s.*

IN the words of the author, this book concerns itself with a complete re-analysis of the reptilian telencephalon as an aid to determining the manner and mechanism of the forebrain evolution. This telencephalon has attracted much interest on all sides from students concerned with the evolution of the forebrain.

The choice of *Testudo geometrica* lies with the general arrangement of the forebrain, suggesting primitiveness and a simplicity which are not due to a lack of any of the essential structural elements. The book endeavours to cover the work done in this field as a whole and at the same time make a careful analytical summary of the telencephalon of the *Testudo geometrica*.

The preface by Kappers gives an indication of the importance of this contribution, and the book must prove very valuable to students of brain research whether they be anatomist or physiologist.

Faune de Belgique

Poissons marins. Par Dr. Max Poll. Pp. ii+452. (Bruxelles: Musée Royal d'Histoire Naturelle de Belgique, 1947.) 420 francs.

LONGCHAMPS (1842), Van Beneden (1871), Gilson (1921) and certain others have made contributions of greater or less importance to the knowledge of the marine fish fauna of Belgian waters. But not until the recent publication of "Poissons Marins" by Max Poll has any comprehensive and systematic work covering the subject as a whole been available. In this book, the author not only synthesizes the results of previous workers, but also makes important contributions of his own to the knowledge of species already familiar in the region and of others recorded there for the first time. In addition to reasonably full systematic descriptions of each species, there are also brief notes on time and place of spawning, seasonal and other migrations, food, habits and economic importance. The usual keys to aid identification are included, and the book is amply illustrated; but some of the drawings could be improved upon. Nevertheless, this is a valuable publication.

G. A. STEVEN

Mathematics

A Text-Book for Technical Students. By Bevis Brunel Low. Second edition. Pp. vii+464. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 17*s.* 6*d.* net.

THE first edition of this excellent text-book appeared in 1931, and it has been reprinted several times. It is amazing how, in a single volume, the author contrived to give some account of algebra, logarithms, trigonometry, plane and solid co-ordinate geometry, geometrical conics, empirical laws, differential and integral calculus, differential equations, finite differences and Fourier's series. Now he has added a chapter on determinants. There are many worked examples throughout the book and nearly eight hundred examples for solution, with answers. The diagrams are exceptionally well drawn. The book will be of great value to technical students.

The Birds of Concord

By Ludlow Griscom. (New England Bird Studies, 2.) Pp. xi+340+16 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1949.) 27*s.* 6*d.* net.

THE area dealt with is roughly one hundred square miles in north-east Massachusetts and is of special interest, since the great American naturalist William Brewster began his ornithological career there in 1868 and for nearly fifty years made continual observations. Brewster's diaries consist of fifty volumes and are now in the Museum of Comparative Zoology at Harvard. Since Brewster's death in 1919 others have carried on the work, so that there are unbroken observations on this area covering nearly eighty years.

The book is divided into two parts: (1) "Population Trends" and (2) "Birds of the Concord Region". In this latter part, in addition to the systematic list, there are interesting notes on migration routes, seasonal bird-life and newly created habitats. Part I deals with a variety of subjects; it is the most interesting section of the book and is well worth consideration by bird students in Great Britain. Starting with a description of the area, climate and vegetation, the author goes on to give details of the effect of civilization and disturbances. This section is of particular interest on account of the long period in which the area has been under close observation. The remainder of this part consists of remarks on the fluctuations in numbers of some birds and animals and the importance of adaptability, followed by some thirty pages on population, declines and increases.

Mr. L. Griscom does not agree that there are periodic cycles in birds and considers that in New England, at least, the winter irruptions of the snowy owl may be due to failure of food supply in the north or to over-population—this owl is a prolific breeder and lays from four to ten eggs. He also gives his reasons for the fluctuations of the ruffed grouse, and brings to a close his discussion on cycles with a note on some general principles of population trends. There are sixteen excellent photographs by various members of the National Audubon Society.

RENÉ DESCARTES (1596-1650)

By Prof. HERBERT DINGLE

On February 11, 1650, René Descartes died in Stockholm in his fifty-fourth year. Galileo had been dead for eight years and Newton was a child of seven. It is customary now to think of Galileo and Newton as the founders of modern science and of Descartes as 'the father of modern philosophy', and in retrospect the titles are justified. The principles of the former thinkers are implicit in all subsequent science and the text of the latter has been explicitly anatomized by all later students of philosophy. Reciprocally, of course, philosophers have regretted the gaucheries of Galileo and Newton, while men of science have forgotten Descartes. There is reason, therefore, in the classification that has been made, but it would have seemed strange in the seventeenth century. At that time all three were placed in the same genus, and, if fertility of crossing is a valid criterion, they were as thinkers of the same species also. The divergence that followed was inevitable, but none the less unfortunate. Let us, three hundred years after his death, try to estimate the scientific significance of Descartes.

His greatest contribution to the fundamentals of all thinking, whether it be called scientific or philosophic, seems to me to lie in his first principle—that the basis of one's system should be that which one cannot doubt. As a rough generalization we may say that earlier philosophers had started with what one ought not to doubt, and later ones with what it is convenient not to doubt. Descartes almost alone took the *impossibility* of doubt as the only valid token and honestly tried to discover what bore it. His solution—the famous *Cogito ergo sum* and its consequences—was perhaps scarcely worthy of the discernment that led to it, but had he done nothing more than sow this one seed of truth and left it to germinate in its own time, he would still have earned his title of the father of philosophy.

At the present time, it is true, its germination seems remote. To change the metaphor, in an age when building material is plentiful, a simple plan available, and workers eager and numerous, the question of the stability of the foundations is apt to be regarded as a tiresome hindrance to progress, and therefore one to be evaded or given whatever answer will most effectively prevent it from obtruding itself. For example, Sir Arthur Eddington, wishing to establish a philosophy on the impregnable rock of pure reason, found the existence of other people neither obvious nor deducible; he therefore *assumed* it. "For reasons which are generally admitted, though I should not like to have to prove that they are conclusive," he wrote[1], "I grant your consciousness equal status with my own." This would not have satisfied Descartes. Again, in a wider sphere, the mathematical form of modern physical relations is equivalent to that of the mathematical theory of probability. Accordingly, a physical picture is drawn to represent those relations which includes entities having a choice of states, with each of which an '*a priori* probability' is associated; and the phrase '*a priori*' is accepted as an exemption from the task of looking deeper. Instead, a 'logic of probability' is sought, which means that instead of starting with what we cannot doubt, we seek to start with what we cannot help doubting—even with doubt itself: uncertainty is made not only a principle but the fundamental principle.

Another tendency in the same direction arises from the axiomatic method of modern logic. Whereas ancient logic was merely an instrument for discovering mistakes—or rather for giving names to mistakes that were obvious—modern logic is creative: it seeks to build as large a calculus as possible from the fewest arbitrary axioms or postulates. This is excellent, and potentially of the greatest value to science, but it is not without serious dangers. When we find that to a certain department of observation a calculus of this type is applicable, the temptation to regard its axioms as 'fundamental truths' sometimes proves irresistible, and principles which it is not only possible to doubt but scarcely possible to credit become enthroned as intuitive principles of philosophy, and the observations on which they have been foisted are thought to have been deduced from them by pure reason alone. It is not difficult to imagine what Descartes would have thought of this.

It is the misfortune of Descartes that his influence was weakest where it was most needed, and where it was overwhelmingly strong our most urgent need now is to remove it. Science absorbed two things from Descartes—co-ordinate geometry and the fundamental division of existence into thought and extension—and, paradoxically, while these were essential to its progress they were alien to its nature. As a mathematical discovery, revealing the correspondence of algebra and geometry, and as a tool for the solution of problems in either, it would be impossible to over-rate the importance of co-ordinate systems. Take them away, and much of the science of the last three hundred years becomes impossible. But it is equally true to say, let them remain and much of the science of the future becomes impossible. What was not at first realized was that the arbitrariness of the co-ordinate system introduced a large element of arbitrariness into the results that were achieved by its use, and to-day, side by side with the technique of using co-ordinate systems, the mathematician has to learn the technique of finding invariants and tensors by which their influence can be eliminated. There is a sense in which Einstein's law of gravitation can be defined as what remains in the ordering of space and time measurements when the effect of co-ordinate systems has been removed. One cannot see how it could have been reached without the use of co-ordinates or without their disuse.

Much the same, though in a slightly different sense, can be said of the *res cogitans* and *res extensa*—thinking things and extended things—into which Descartes divided the realm of existence. To him the material world was something completely independent of the mind that perceived it. It had one fundamental characteristic—extension. Its other apparent qualities—colours, temperatures, sounds and so on—were merely a confused kind of knowing, ultimately mental in character, which could all be thought away from it, and he accordingly gave little attention to them. His physics was thus deprived of most of the data on which a successful physics could thrive, and the best he could do with the extended world was to fill its apparently empty spaces with an inapprehensible

'primary matter' in which vortical movements carried the heavenly bodies around in their courses. With thinking things he made no progress at all.

Galileo, on the other hand, with much less theorizing, instinctively adopted the practice which has been the hall-mark of science ever since. Instead of attributing observed motions to hypothetical motions conceived to be necessities of thought, he described them in terms of measurements made with rods and water clocks, and thus discovered the regularities that they exhibited. This was a procedure that could be developed. Newton could complete Galileo's work on motion and show the barrenness of the Cartesian vortices. Moreover, later workers could treat in the same way those very sensations that Descartes had despised. Hotness and coldness could be described in terms of measurements made with thermometers and radiometers and their regularities discovered; colours could be described in terms of measurements made with spectrometers and photometers and laws of colour formulated. Other sensations could be similarly studied, and the whole modern science of physics thus grew up as a rational correlation of sense experiences.

But while it was the Galilean practice that was followed, it was in the light of the Cartesian philosophy that it was seen. The men of science were correlating their observations, but thought they were discovering the nature of the independent, objective, extended world that Descartes had bequeathed to them. The philosophy of Descartes held the science of the eighteenth and nineteenth centuries in an iron grip, all the firmer because it was unrecognized. Berkeley had shown the hollowness of the extended things and Hume that of the thinking things, and they were unanswerable, but the mischief had been done. They might as well not have lived for all the effect they had on the ideas of the men who were making scientific history. Nor is this entirely to be deplored. It is very questionable whether the great advances of those two centuries would have been possible without the simple concrete picture of a passive extended universe of matter presented for study to independent minds. There was much to be done that could be effectively conceived in those terms, and the excesses of an over-confident materialism were perhaps not too high a price to pay for the discoveries and correlations that would otherwise have been achieved, if at all, only with much more difficulty, less general understanding, and far less speed.

It was, indeed, not until almost our own time that the Cartesian doctrine began to mislead. Experiments such as that of Michelson and Morley were the first that utterly refused to accommodate themselves to it. The facts compelled us to substitute the result of the actual process of measurement for the supposed objective extension of the arms of the apparatus, and that result was found to depend inescapably on the particular co-ordinate system in terms of which it was interpreted. The Cartesian world of extended things was seen, in fact, to be an illusion. What physics was concerned with, and always had been concerned with, were the results of its own specified operations, not a hypothetical world of dead being on which those operations were conceived to have been performed.

Such a long-standing prejudice, however, is not easy to abandon. Physics to-day is in a transition stage, in which many of its devotees, rather than abandon their Cartesian universe, are prepared to make it nonsensical by giving it contradictory properties. Others accept the relativity requirement where they must, but maintain the incompatible traditional view where they still can. Such anomalies must be expected; they will be temporary. A more portentous aspect of the new freedom is the rise of scientific psychology. Such a thing is impossible under the Cartesian scheme: thinking things cannot be related with extended things. To-day emotions and hallucinations are being studied exactly as though they were sensations or cognitions of a material world. Here the Cartesian duality is not refuted: it is simply ignored—a far more fatal treatment.

It is perhaps a melancholy thought that we can best celebrate the death of Descartes by expediting the death of his system; but there are compensating reflexions. In a world of enlarging experience no philosophy can hope to live for ever, and we can only stand in respectful admiration before one which, born at the beginning of a great new era of thought, could direct the course of that thought for two hundred and fifty years. Its passing leaves a blank which, when it is fully realized, will be seen to demand a successor, and no successor can be acceptable that does not start where Descartes started, with that which cannot be questioned. As the first clear exponent of that principle at least he is immortal.

[1] "The Nature of the Physical World", p. 283 (Camb. Univ. Press, first edit.).

MECHANISM OF DETONATION

A DISCUSSION on "Detonation" was held by the Royal Society on November 10, in the Society's rooms, with the president in the chair. Some of the speakers described work which was done during the Second World War, while others described work which has recently been completed or is still in progress.

The discussion was opened by Dr. W. G. Penney, who described current ideas on the structure of the reaction zone. The leading edge of this zone is a strong shock front in which the pressure rises to its maximum value in a distance of order 10^{-5} cm., while at the same time the temperature rises high enough to start reactions at a very fast rate. The reaction energy may be regarded as heat supplied from an external source; and the result is to produce an expansion of the reacting material, with a fall in pressure but an increase in temperature. The width of the reaction zone is a few millimetres for most solid explosives, and the time of transit of any particle through the zone is approximately one microsecond. In most cases, the width of the reaction zone is small compared with the radius of curvature of the shock front, and the flow through the zone can therefore be regarded as one-dimensional. Conservation of momentum then leads to a linear relation between pressure P and specific volume V throughout the zone:

$$P - P_0 = D^2(V_0 - V)/V_0^2. \qquad (1)$$

The detonation velocity is D, and zero suffixes refer to undisturbed material ahead of the wave.

Conservation of energy leads to the second Rankine-Hugoniot equation

$$E - E_0 = Q + \tfrac{1}{2}(P + P_0)(V_0 - V), \qquad (2)$$

where E is the internal energy and Q the heat added from chemical reaction or from some other source.

Given E as a function of P and V, the relationship (2) gives a family of curves on a (P, V) diagram with parameter Q. Taking Q to be the total energy supplied by the reaction, then conditions at the rear of the reaction zone are given by the intersection of the line (1) with the curve (2), which is concave upwards. The Chapman–Jouguet hypothesis states, in effect, that D has the minimum possible value consistent with a real solution for P and V, that is, that the line (1) touches the curve (2). This determines D for a given Q, and it can then be shown that the particle speed at the rear of the reaction zone is sonic relative to the shock front and so equals $D - c$ relative to fixed axes.

A region of uniform conditions behind the reaction zone is possible if the product gases are contained by a piston moving with velocity $D - c$. If the piston is slowed down, then a rarefaction wave will travel forward from it with velocity c relative to the material, that is, with velocity D relative to fixed axes, and so will never catch up the reaction zone. On the other hand, if the piston is accelerated, a shock wave will travel forward at supersonic speed, run right through the reaction zone and increase the strength and the speed of the shock front. It is therefore possible in principle to increase the detonation velocity, but this will ultimately decrease again to its Chapman–Jouguet value if the piston is slowed down, since the flow behind the reaction zone is now subsonic relative to the front.

If one attempts to compute conditions throughout the reaction zone, various uncertainties in points of detail are encountered. These are most simply illustrated by considering the detonation of a gaseous mixture. The leading edge is a shock in which molecular translations and rotations assume a Boltzmann distribution, but vibrations and dissociations are relatively unexcited. Energy then passes from the translational and rotational degrees of freedom into the other modes, and chemical reactions begin. Even a rough theoretical treatment of these processes would be instructive. Such a treatment, although feasible, has not yet been attempted.

Sir Geoffrey Taylor said that in a number of special cases a similarity condition can be used to reduce the number of independent variables to one, thus allowing a numerical solution to be obtained directly. Very often there is no unit of length given by the initial conditions, and a possible solution is one in which the whole system expands uniformly with time. This similarity rule may be applied to certain detonation waves provided the reaction zone is of negligible width. He had given such solutions for the air wave caused by the uniform expansion of a rigid sphere, and for the air wave caused by the explosion of a point source of finite energy. Another similarity problem is that of a plane detonation wave started at a definite plane. The relationship between particle velocity u and sound velocity c is very nearly linear, so that u falls nearly linearly with distance behind the front until it reaches some definite value and then remains constant back to the boundary. This value is either zero or $-c$, according as the rear boundary is rigid or free. Much the same is true for a spherical detonation wave except that his solutions give infinite pressure and velocity gradients just behind the reaction zone. Another problem which reduces to one independent variable is that of the expansion of a long cylindrical case enclosing a stick of explosive. Sir Geoffrey showed a photograph which confirmed his prediction that all fragments from the wall would move in directions making nearly the same angle with the shell axis.

In the subsequent discussion Dr. S. Paterson pointed out that Devonshire had shown that the Chapman–Jouguet condition is satisfied for a spherical detonation wave at a point where the reaction is not quite complete.

Prof. H. Jones showed how P and V at the end of the reaction zone can be determined from the detonation velocity (of a plane wave) and its variation with the initial specific volume V_0 of the explosive. For a given V_0, the Chapman–Jouguet condition implies that the line (1) touches the curve (2); but if V_0 is varied, then (1) becomes a ruled surface touching the surface (2) in (P, V, V_0) space, along a line which will be continuous for physical reasons. This contact now gives two conditions, one of which is the usual Chapman–Jouguet condition, while the other leads to the equation

$$P = D^2/V_0(2 + \alpha)\{1 - d(\log D)/d(\log V_0)\}, \quad (3)$$

with a similar equation for V. The only unknown is α, which must be calculated from some assumed equation of state. It can, however, be shown that α is a small positive quantity of order 0·2, so that one need estimate α to only 10 per cent accuracy in order to determine P and V within 1 per cent. An upper limit for P, not more than 10 per cent too high, can be obtained at once by setting $\alpha = 0$.

Prof. Jones also outlined his theory of the variation of velocity of detonation of a cylindrical charge with the radius R. If a stream tube near the centre of the charge increases in radius by a factor z while passing through the reaction zone of length L, then

$$(D_\infty/D_R)^2 = 1 + K(z^4 - 1), \quad (4)$$

where $K \simeq 2$. One can determine z as a numerical function of L/R, and when this is small the change in D is proportional to it. Given D for several values of R, it is possible to calculate L.

Dr. W. M. Evans briefly described how detonation velocities, probably the easiest to observe among the many physical properties associated with detonation, can be measured, for example, either by the Dautriche method using 'Cordtex' or with a rotating drum or mirror camera. The latter method has great advantages over the former, and a typical camera is that developed by the Road Research Laboratory during the War, which has a rotating mirror giving a maximum writing speed of 1 mm./microsec. Considerable work has been carried out on the variation of D with factors such as density of loading, grain size, confinement and diameter, and from such observations values of L have been deduced which vary from about 1 mm. to 10 mm. for various explosives.

Among the more recent research is a study of the passage of the detonation wave from a fast to a slow explosive and *vice versa*. The camera can also give false results by recording the velocity of the air shock outside the charge. To avoid this danger, a series of holes are drilled either parallel to the axis of the charge or parallel to a radius and lined with copper tubes to keep away the air shock, and the camera records the time of arrival of the wave at the bottom of each hole. With these techniques, it was found that, for a number of pairs of cast explosives, the change in detonation velocity is completed within a millimetre or so from the interface, a result some-

what contrary to that expected and, indeed, not in agreement with those published by other observers. The work is being continued with other pairs of explosives.

Mr. C. A. Adams described an improved form of the R.R.L. camera which is now in use in the Armament Research Establishment. This employs two telephoto lenses which view the object through two slits at right angles. The mirror rotates at 40,000 r.p.m., giving a writing speed of 4 mm./microsec. At this speed it is essential to evacuate partially the camera in order to cut down wind drag on the mirror. A higher writing speed has been obtained in a single-lens camera by using a compressed air turbine to rotate a mirror at 80,000 r.p.m.

Dr. J. S. Courtney-Pratt described an apparatus which gives an equivalent writing speed of 24 mm./microsec. by forming an image on a light-sensitive screen which is scanned by a very rapidly deflected electron beam. This shows that the detonation velocity of lead azide attains its steady value in less than 5×10^{-8} sec.

Prof. R. M. Davies described work on the detonation of gas mixtures in a long tube. Pressure gauges flush with the wall and in the closed end measure the hydrostatic and reflected pressures respectively. Either a piezo-electric gauge is used or a pressure bar, with a condenser unit or strain gauge to measure the displacement of the far end of the bar as a function of time. The pressure bar using compressional waves gave poor results on account of dispersion, but considerable improvement has been obtained by using torsional waves in the bar and recording them optically. The time resolution is provided by a rotating mirror, driven by an air turbine, with a writing speed of 3 mm./microsec.

Dr. P. Bowden said that initiation usually starts at hot spots formed either by: (*a*) adiabatic compression of air bubbles, or (*b*) localized frictional effects on the containing surfaces, on grit particles or on particles of explosive, or (*c*) viscous heating. The extreme sensitivity to impact of nitroglycerine confined in a small hollow has been shown to be due to minute air bubbles, and the fact that air between the crystals contributes to the initiation of solid explosives was demonstrated by the reduction in their sensitivity with reduced atmospheric pressure. On being heated, initiators explode without melting and so are very sensitive to friction. Courtney Pratt has shown that they attain their full detonation velocity practically instantaneously. The less sensitive explosives used for bulk fillings melt before exploding and usually take some microseconds to build up to the full detonation-rate. A detonation velocity of order 2,000 m./sec. is often observed in the early stages, and extraneous factors such as grit and air bubbles probably produce an important effect here. A subsequent speaker stated that this low-velocity detonation often occurs for a short time during the fading of detonation in a charge of small diameter.

Dr. A. R. Ubbelohde stated that lead azide behaves like a less sensitive explosive if suspended in an inert liquid. He went on to say that by adding rock salt, the temperature in the reaction zone of T.N.T. can be reduced by some 500° without materially increasing the reaction time, so that activation energies must be very low. He also pointed out that many chemical reactions will proceed detonatively if the scale of the experiment be large compared with the necessary reaction-zone width. An example is the transformation from amorphous to crystalline arsenic. Another possible example is the detonation of ammonium nitrate. The width of the reaction zone is large for this material, and detonation could only occur if the quantity of material were sufficient. It is well known that small quantities of ammonium nitrate cannot be detonated, whereas several disastrous explosions have shown that it can be detonated in amounts of the order of a thousand tons. A similar example quoted by Sir Geoffrey Taylor was that of coal dust–air mixtures in long tunnels, where the reaction zone may be some 300 yd. long.

Dr. Taylor emphasized the need for a study of the detailed kinetics of the reaction zone. He said he has evidence that in the low-order detonation there is thermal decomposition in a surface reaction. The reaction zone length agrees reasonably well with rates of burning extrapolated from closed-vessel experiments.

H. H. M. Pike

INTERNAL CONSTITUTION OF THE EARTH

A GEOPHYSICAL Discussion on the "Internal Constitution of the Earth" was held at the Royal Astronomical Society on November 25, 1949. Dr. R. Stoneley was in the chair, and, in introducing the subject, said that until the early years of the present century the only observational evidence for the internal constitution of the earth came from astronomical observations. The period of the variation of latitude, combined with a knowledge of the value of the precessional constant, gave a mean rigidity for the whole earth approximately equal to that of steel. No information on the internal distribution of rigidity, or of density, was available. The so-called laws of density of Laplace and Roche were merely assumptions of suitable mathematical form to render certain differential equations, involved in calculating the figure of the earth, more easily soluble. Wiechert's hypothesis, propounded in 1897, was the first to be based on physical reasoning. He supposed there was an iron core to the earth of density 8·2 (all densities in gm. per c.c. throughout this article) and radius 0·78 of that of the earth, the remainder having mean density 3·2. He arrived at it by considering the composition of meteorites. Any hypothesis must agree with the value of the moment of inertia of the earth, $0\,334\ Ma^2$ (where M is the mass of the earth and a its radius), derived from the precessional constant and the theory of the figure of the earth. This value taken by itself gives evidence of a concentration of density towards the centre, since the value for a homogeneous sphere would be $0\,4\ Ma^2$. More detailed evidence has been obtained since then from the times of arrival of the various pulses received from earthquakes. It was found by Gutenberg that a core of radius $0\,545a$ would agree with seismological results. However, Prof. H. Jeffreys was able to reconcile the difference between this value and Wiechert's by taking into account the effect of compressibility. The failure of the core to transmit S-waves is evidence of its being liquid. From the complete travel-time data, it is possible to determine uniquely the velocities of P- and S-waves as functions of the distance from the centre.

To obtain the density distribution a further assumption must be made, namely, that in between the major discontinuities the earth is chemically homogeneous, and that the increase of density within

each layer is solely due to the compressibility. In this way a differential equation can be set up and integrated numerically, as was first done by Adams and Williamson and later in more detail by Prof. K. E. Bullen[1]. The solution obtained indicates a fairly steady increase of density in the mantle from about 3·3 near the surface to about 5·8 near the core, with a large discontinuous jump at the core to a value of about 9·6, values as high as 12 eventually being reached towards the centre of the earth. There is good evidence for the existence of an inner core of yet higher density within the main one, and rather uncertain evidence that this is rigid.

Mr. H. Bondi described a paper by Kuhn and Rittmann[2] in which the authors adopt a radically new approach to the problem of the interior of the earth. Instead of starting, as in most other theories, from the known physical data, they begin with the theory of the origin of the earth and discuss the developments that would follow during the ageing of the earth. Only after a model of the earth has been constructed in this way do they examine whether its physical properties are compatible with the geophysical data. Unfortunately, this interesting and original approach is marred by the fact that the authors base their views on cosmogonical ideas which are widely considered to be wrong. They assume that the earth once formed part of the sun, although there is no evidence for, but a good deal of evidence against, such an assumption. Secondly, they assume that hydrogen formed only about 30 per cent of the mass of solar material, whereas now there are good reasons for believing that more than 98 per cent of the mass of the sun consists of hydrogen. In the face of these changes in cosmogony and astrophysics, the theory loses much of its force.

The authors then consider the development of an earth originally containing about 30 per cent of hydrogen as well as a considerable proportion of other light elements. All these escape readily from the surface of the planet, but not from the interior owing to the slowness of diffusion. Convection currents relieve the outer layers of most of their hydrogen, and are also supposed to enrich them in radioactivity, and finally the outer crust solidifies and thereby makes any further escape of gas very difficult. In this way the authors arrive at a model of the present-day earth consisting of a thin (70 km.) crystalline crust enclosing a liquid region, highly viscous and poor in hydrogen in its outer parts (down to about 2,700 km. depth), but consisting of almost unchanged 'solar' material near the centre.

This model can be reconciled with the seismic data by consideration of the variation of the relaxation time of the liquid interior with depth. The authors claim that down to about 2,900 km. the relaxation time is so long (about 1 year) that the liquid behaves like a solid with respect to earthquake waves; but lower down, the presence of the highly mobile hydrogen atoms reduces the relaxation time to a fraction of a second, so that transverse waves are no longer propagated. Similarly, the jump in the velocity of longitudinal waves and the high central density are ascribed to the presence of hydrogen in the deep interior. It is necessary to postulate a diminution of bulk modulus as well as the loss of rigidity at the boundary of the core.

Dr. W. H. Ramsey described an entirely new theory of the interior of the earth which he himself has advanced recently[3]. He believes that the jump in density at the core boundary represents, not a change in chemical composition, but a special kind of phase-transition in a single substance. Ordinary phase-transitions usually involve small density changes, because only a rearrangement of molecules is concerned; in this case it is to be supposed that the atoms or molecules are broken up by the change. With indefinite increase of pressure, successive transitions of this kind will result in the material ending up as a Fermi gas. As an example, Dr. Ramsey cited solid hydrogen, which, it has been calculated, will change from H_2 to a 'metallic' phase, H, in which it resembles in properties the alkali metals, at a pressure of $0{\cdot}8 \times 10^6$ atmospheres. The density increases from 0·35 to 0·77 by the transition. Thus, if a large mass of hydrogen were a suitable model for a planet, it would possess a dense metallic core and a less dense outer mantle with non-metallic properties. Other elements, notably tin, arsenic and phosphorus, are capable of existing under experimentally attainable conditions in metallic and in non-metallic phases, the latter being much less dense. (For example, metallic arsenic has density 5·1, non-metallic, 2·0.)

The best test of the theory is to calculate the mean densities of the other planets, assuming all of them to be of similar chemical composition to that of the earth. The results are in gratifying agreement with the theory, except in the case of Mars. Taking account of the effects of a possible concentration of small quantities of the heavy elements towards the centre of the earth has considerably reduced this discrepancy.

Another feature of the theory is that it can account for the anomalies in the velocity distributions found just outside the boundaries of the cores. The increase in the *P*- and *S*-wave velocities with depth is arrested about 100 km. outside the outer core, so that they are about 1 per cent less at the boundary than they otherwise would be. A similar, but more pronounced, anomaly occurs for *P* just outside the inner core. In the mantle the metallic phase can exist as an excited state; the excitation energy is about 6 eV. per molecule, which can be calculated from other empirical data. This excited state is referred to as a conduction band. Similarly, in the core, the non-metallic phase can exist in an excited state; but the excitation energy in this case is found to be 24 eV. per molecule. At the temperatures likely to prevail, kT (Boltzmann constant times the absolute temperature) is about 1 eV. Hence, although in the core the chance of a molecule changing into the non-metallic phase is only exp-24, in the mantle the chance of a molecule being excited into the metallic phase is exp-6, or an appreciable fraction of one per cent. The effect is thus to produce a small amount of a mixed phase at the base of the mantle in which the bulk modulus (and also the rigidity) is reduced below that for 'pure mantle' by something of order one per cent. The negligible probability of a mixed phase occurring on the other side of the boundary explains why the discontinuity is so sharp.

The theory is also more reasonable in its predictions of the chemical composition of the earth. The ratio of iron to stony meteorites is at most 1/36, and the percentage of iron by weight for all meteorites at most 25, whereas the core of the earth contains 40 per cent of the total mass. Moreover, the inner core presents a difficulty on the ordinary view. If it is a different chemical substance from the iron of the outer core, it must be denser than iron. No abundant element can be found to fulfil this condition. On the

present theory, the inner core would be interpreted as a second-phase transition, another step on the way towards the Fermi gas.

Dr. Ramsey concluded by explaining why he differed from Prof. Bullen's view, that the compressibility of materials is independent of chemical composition at the pressures prevailing in the earth[4]. It is well established that density is independent of chemical composition at the very high pressures prevailing in white dwarf stars. Density at these pressures depends only on the ratio of atomic weight to atomic number, which is about 2 for most elements. Considering the extreme cases of deuterium and gold, the former is already a Fermi gas of density 2 at a million atmospheres and will undergo no further transitions with increasing pressure, whereas the latter has density at least 30 at this pressure and may possibly increase at higher pressures. Hence, if the density of deuterium ultimately becomes the same as that of gold, their compressibilities must be very different at pressures above a million atmospheres. Bullen framed his hypothesis because of the similarity of the pressure–compressibility relationships in the core and mantle, which he assumed to be chemically distinct. But this similarity is seen by the present theory to be due to the fact that they are chemically identical. His hypothesis, suitably modified, can be taken over into the present theory without inconsistency.

The third speaker, Prof. H. Jeffreys, began by pointing out an alternative way of escape from the difficulties of explaining the wide differences of density among the planets, even if one does want to grant the principle of uniformity of composition of the universe. This is by using Lyttleton's theory[5] that the planets developed in two stages, a core forming within each parent planet during the first stage, and then each parent breaking up into smaller ones due to excessive rotation afterwards. Prof. Jeffreys thought this theory mechanically possible, and it would easily explain why the planets in the solar system are so heterogeneous.

Commenting on Kuhn and Rittmann's theory, he said that they appear to have overlooked the importance of convection, and have calculated the rate of loss of hydrogen from the original ball of solar material solely from the ordinary laws of diffusion. Evidently convection must play an important part, because the earth has succeeded in getting rid of its heat and solidifying, at least in the outer parts. In any event, if their theory that the cooling planets retain their hydrogen were correct, the larger planets would be denser because of the greater pressure inside. In fact, for example, the density of Jupiter is only one-quarter that of the earth. Another important basic assumption in their argument is that the crust of the earth solidified in a few thousand years. The possible screening of the surface of the earth by a dense atmosphere of steam could have prolonged the cooling by a factor of a thousand or so. This would have given ample time for the escape of hydrogen without being an appreciable fraction of geological time.

Turning now to the arguments for and against the existence of an iron core, Prof. Jeffreys went on to cite an objection lodged by A. Eucken, who pointed out that since silicon has a high boiling point, one would expect it to find its way into the core. This could be dealt with by supposing silicon hydride to be formed first, and the gaseous envelope of this material to be oxidized to silica by the water present at a later stage, and the hydrogen lost. Positive points in favour of an iron core are that it gives the right density and explains why it is liquid, and would be expected to give a sharp transition. Prof. Jeffreys emphasized that seismological evidence shows that the transition must occur within an extremely short distance, of the order of a few kilometres.

The first point in favour of Dr. Ramsey's theory is that, at the enormous pressures prevailing, a chemical change implying even only 2 per cent decrease in specific volume would be bound to take place. But the theory, as developed so far, is purely qualitative and does nothing to predict at what pressure the transition should occur, what the change of density would be, or why the metallic phase is liquid. It does, however, explain why the boundary of the core is sharp and why the densities of Venus and the earth differ so much more than expected from their difference in size. Ramsey's theory of the instability of small cores[3] leads to the result that at a certain critical size a slight change of mass could produce large changes of density. Calculations show that Venus and the earth are not far above that critical size.

Coming finally to the question of the small anomalies in the *S*- and *P*-wave velocity distributions just outside the core, Bullen has endeavoured to explain these by a concentration of denser materials, keeping to the idea that the compressibility is a function of pressure only for all substances. So far, no likely substance has been found which could give the required concentration of density. Ferrous sulphide and fayalite have been suggested, but the former has been excluded because the sulphur atoms are so large, and the latter because fayalite crystallizes last from an olivine magma and would hence be expected to appear on the outside of the mantle, not on the inside.

In the ensuing discussion, considerable interest was displayed in Dr. Ramsey's new theory, and in response to questions he added the following remarks. The argument for the existence of iron cores to all the planets because iron meteorites are found is not very forceful; there is no reason why there should not be local concentrations of iron in planets with structures following Ramsey's scheme, and that could account for all the iron meteorites found, if indeed the exploded planet theory of their origin is acceptable. In several respects the theory requires no serious changes in existing views on the properties of the interior. The conductivity of the metallic phase is likely to be of a similar order of magnitude to that of iron; the conductivity of metallic hydrogen, for example, has been calculated to be about forty times that of silver under normal conditions. There is, therefore, no immediate need to review the theories of the magnetic field of the earth put forward by Elsasser and Bullard. The inner core would be expected to be rigid on this theory for much the same reasons as on Bullen's. Knowledge of the temperatures in the interior of the earth is very uncertain, and Ramsey's theory could hold provided that the temperatures lie in the range, say, 10,000–30,000° K., which, so far as is known at present, would be quite possible. There is no apparent mechanism for concentrating the radioactivity of the earth in its upper layers, since no chemical sorting need be supposed to have occurred. However, the basis of the conclusion that this has, in fact, taken place is the assumption that the earth has been cooling ever since its formation. There seems no real

need for this assumption, since the heat generated internally by a uniform distribution of radioactivity of the same density as is found for meteorites would not have brought about an inadmissible rise of temperature in geological time. R. I. B. COOPER

[1] Bullen, K. E., "Introduction to the Theory of Seismology" (Cambridge University Press, 1947).
[2] Kuhn, W., and Rittmann, A., *Geol. Rundsch.*, **32**, 215.
[3] Ramsey, W. H., *Mon. Not. Roy. Astro. Soc.*, **108**, 406 (1948); and *ibid.*, *Geophys. Supp.*, **5**, 409 (1949).
[4] Bullen, K. E., *Mon. Not. Roy. Astro. Soc.*, *Geophys. Supp.*, **5**, 355 (1949).
[5] Lyttleton, R. A., *Mon. Not. Roy. Astro. Soc.*, **98**, 633 and 646 (1938); *ibid.*, **101**, 349 (1941).

OBITUARIES

Dr. Clifford Dobell, F.R.S.

WITH the passing of Clifford Dobell on December 23, 1949, science has lost a notable worker in the field of protozoology, one who has made important additions to our knowledge in human and comparative parasitology.

Dobell was born in 1886 and educated at Sandringham School, Southport, proceeding later to Trinity College, Cambridge, where he had a brilliant career. Commencing with his graduation as B.A. with first-class honours in the Natural Sciences Tripos in 1906, he was eventually awarded the Sc.D. in 1942. He was elected a fellow of Trinity College in 1908 and during 1908 and 1909 held the Balfour Studentship at Cambridge. He was awarded the Walsingham Medal of the University and was Rolleston Prizeman, Oxford and Cambridge, in 1908.

At Cambridge, Dobell was a pupil of that great zoologist, Adam Sedgwick, and in his classical monograph on the life-history and chromosome cycle of *Aggregata eberthi*, he pays a sincere and graceful tribute to the debt he felt he owed to his former master. The materials for this study were collected chiefly at the Zoological Station in Naples in 1908 and in Monaco in 1913.

Early in his career Dobell was attracted by the parasitic Protozoa, and it is in this field that he made his most notable contributions to science. His growing reputation led, in 1910, to his appointment as assistant professor of protistology and cytology at the Imperial College of Science and Technology, London, where he remained until 1919. Here he carried further his researches on the parasitic Protozoa of animals and continued his study of the materials previously collected at Naples and Monaco.

Dobell was now fully equipped, in knowledge and experience, to turn his energies to the study of the human intestinal Protozoa, in which he never afterwards lost interest and on which he became a world authority. His work had special application during the First World War, when he was responsible for the training of protozoologists, especially in connexion with the most important application of protozoology under war conditions, the diagnosis of infections of *Entamœba histolytica*. At this period, he made a close study of the human parasitic amœbæ from the aspects of morphology and classification, and was also one of the workers chiefly responsible for the improved methods of treatment with emetine evolved at that time. In 1918, he was elected a fellow of the Royal Society in recognition of his outstanding work, while in the following year he produced his second classic, "The Amœbæ Living in Man", a work still constantly consulted in clinical and research laboratories.

Dobell now joined the National Institute for Medical Research as protistologist, and this Institute was the scene of his labours for the rest of his life. Here he continued his work on *Aggregata eberthi* and his studies on the human intestinal Protozoa, the results of the latter studies being embodied in the important publication (with F. W. O'Connor) in 1921, "The Intestinal Protozoa of Man". About this time he made comparative studies of the amœbæ of man and macaque monkeys, in which he claimed to have established the identity of the species in these primates.

No account of Dobell's work would be complete without a tribute paid to his masterly study, "Antony van Leeuwenhoek and his 'Little Animals' ". This must be considered one of the very great books connected with the study of natural history. Apart from its intrinsic interest and importance as a record of the work of the 'father of protozoology', its compilation from original sources of three hundred years ago was obviously a labour of love to the author. Imagine the application and assiduity of the man who, to complete it, had not only to learn a foreign language in order to study original documents but also had to familiarize himself with the more or less archaic form of that language as it was written three centuries ago. All will admit that the book is a monument to the author as a great research worker and a great scholar.

Dobell in all his scientific work was meticulous and accurate. His quality as a writer and scholar was not all expended on his literary masterpiece referred to above but was also evident in his scientific publications. In his human contacts he was a curious medley. His wide learning attracted to him many workers in search of the assistance he could give, and to those whom he considered worthy he gave generously; but he could not, and would not, suffer fools gladly. His interests were almost wholly scientific and within his own field his knowledge was extraordinary, so that an afternoon spent with him was always worth while and usually amusing. His sense of humour, unsuspected by many, is evidenced in some of his lighter writings, such as his satire on the mythical Dr. O. Uplavici (translated from the Czech "On Dysentery!"), who haunted medical literature for fifty years as an author (!), and his protests against illogical and ignorant scientific nomenclature in "On Teranympha and other monstrous Latin Parasites".

Dobell and his work will occupy a permanent place in the annals of protozoology. H. E. SHORTT

Dr. T. Lewis Bailey

DR. T. LEWIS BAILEY, chief inspector of alkali, etc., works, Ministry of Health, during 1920–29, died at Redhill from heart failure on December 13, at the age of eighty-five.

Dr. Bailey was appointed sub-inspector of alkali works in 1908 and for five and a half years was in charge of the South Wales district, acting as assistant to Dr. Fryer. In these years he had a wide experience of the various industries in the West Country, including tinplate manufacture in South Wales and arsenic production in Cornwall. During this period the problem arising from atmospheric pollution by tinplate flux works was satisfactorily

solved. In 1914 he succeeded Mr. Ballard as inspector in south-west Lancashire, North Wales and Ireland. In 1920, on the retirement of Mr. Curphey, he was appointed chief inspector.

During his tenure of office Dr. Lewis Bailey devoted much time to the question of effluents from ammonia plants, and in this connexion he was led to consider the whole process of coal gas purification with the view of providing an ammonia liquor of a less noxious character. He also took particular interest in the subject of water scrubbing on Gay Lussac tower gases as a means of reducing the acidity of sulphuric acid plant escapes, and in the elimination of sulphur oxides from waste gases arising from the combustion of fuel. He was an original member of the Government Chemist Committee under the chairmanship of the late Sir Robert Robertson which was charged with the examination of proposals for gas washing at the Battersea Power Station.

In 1929 he retired on reaching the age of sixty-five years, and from that time had lived quietly in south-east England.

Prof. W. S. Lazarus-Barlow

Prof. Lazarus-Barlow, whose death occurred on January 15, was one of the earliest experimental pathologists in Great Britain to turn his attention to cancer.

After filling pathological posts at Cambridge, St. George's and Westminster Hospitals, where a post-mortem snick of the thumb led to the loss of his left arm, Lazarus-Barlow was made director of the Cancer Research Laboratories of the Middlesex Hospital. Fifty years ago, these Laboratories consisted of about eight small rooms on the ground floor, packed to capacity by men and women drawn to the twofold problem of the cause and cure of cancer. Lazarus-Barlow saw that with the growth in the use of X-rays and radium there was an urgent need for fundamental knowledge of the effects of these agents upon living structures, so he and his colleagues took up experimental studies upon these vital reactions of the cell; and it was found that a living cell exhibits much greater sensitiveness to radiation when it is in a state of active division than when in its growing phase. Lazarus-Barlow in particular showed the differential response of tissues according to whether the radiation dose is given in a short or a long period of time (QT = constant). Such a finding had an obvious bearing upon the radiation treatment of cancer. As early as 1909 he gave the Croonian Lectures of the Royal College of Physicians, choosing the subject of "Radioactivity and Carcinoma".

In view of the widespread occurrence of radium in Nature, it is not perhaps surprising to find it present in organic life. By strictly quantitative methods, Lazarus-Barlow showed the presence of radium in normal and malignant tissues, and that a pre-cancerous condition can be set up by a prolonged exposure of animal tissues to gamma-rays.

Lazarus-Barlow was a fine exponent of his subject and a writer who served the needs of many students of pathology. His two chief books were "A Manual of General Pathology" (1898) and "The Elements of Pathological Anatomy and Histology for Students" (1903).

Margaret R. Shackleton (Mrs. F. G. Mann)

The death of Margaret Shackleton at Cambridge on January 26 will come as a shock to her many former students of University College, London, where she assisted the late Prof. L. W. Lyde in building up the Honours School of Geography from 1920, soon after the courses were begun. Shortly after her marriage she published her deservedly popular "Europe: a Regional Geography" (1934), of which she had just completed a thorough revision for the fourth edition at the time of her death. She returned to lecturing in Cambridge during the War, to students evacuated from Queen Mary College, London, and was actively engaged on research into demographic problems of the Danubian lands.

L. D. S.

NEWS and VIEWS

College of Aeronautics, Bletchley: Mr. A. D. Young

Mr. A. D. Young has been appointed to the chair of aerodynamics in the College of Aeronautics, Bletchley, in succession to Prof. W. J. Duncan, recently elected Mechan professor of aerodynamics and fluid mechanics in the University of Glasgow (see *Nature*, November 26, 1949, p. 905). A graduate of the University of Cambridge, Mr. Young spent a year in postgraduate research at the University Aeronautics Laboratory and then joined the Aerodynamics Department of the Royal Aircraft Establishment. He remained there until he went to the College of Aeronautics in 1946, where he is at present deputy head of the Department of Aerodynamics and senior lecturer in aerodynamics and gas dynamics. While at the Establishment he covered a wide range of experimental research, with some emphasis on flaps and other high-lift devices and on the general problem of stalling. He carried out experiments in the high-speed tunnel, particularly on tunnel-wall interference and on roughness effects. Mr. Young was also responsible for much full-scale research, including measurements of the drag of laminar-flow wings in flight. But his best known and most fundamental research work has been in the application of theory, first to the study of the boundary layer and the cognate problem of skin-friction at low speeds and later the extension of such theory to problems of compressible flow. In this field he is an acknowledged authority.

Standard Frequency Transmissions from Great Britain

In 1948 the Department of Scientific and Industrial Research announced that arrangements were being considered for an experimental service of standard-frequency radio transmissions from the United Kingdom (see *Nature*, **162**, 269; 1948). A committee under the chairmanship of Dr. R. L. Smith-Rose established the need for such a service, and at the request of the Department the General Post Office assumed technical responsibility for the transmissions, which are taking place from the Rugby radio station.

The service began on February 1 on the following three frequencies, each being transmitted at a power of 10 kW.: 0544–0615 (hours G.M.T.), 5 Mc./s.; 0629–0700, 10 Mc./s.; and 1029–1045, 60 kc./s. Each transmission is modulated in accordance with a fifteen-minute cycle, where applicable, at the following minutes past the hour: 59–00, 14–15, 29–30 and 44–45, slow morse call sign *MSF*, followed by a speech announcement; 00–05, 15–20, 30–35 and 45–50, carrier-modulated with 1,000-c./s. tone; 05–14, 20–29, 35–44 and 50–59, unmodulated carrier. It is proposed to add in due course 1-c./s. pulses during the first five minutes of each period at present unmodulated.

The transmissions on 60 kc./s. should be received throughout the United Kingdom and Western Europe and enable local standards to be calibrated with high precision; those on 5 and 10 Mc./s. form part of an international programme designed to give reliable world cover on one or other of the frequencies, 2·5, 5, 10, 15, 20 and 25 Mc./s., which have been allocated to standard frequency services. The transmissions on these frequencies from the United States National Bureau of Standards station *WWV* are not always satisfactorily received in the United Kingdom and farther east. It is hoped to learn from the experimental service now being initiated to what extent reception in the European area is improved by transmissions from the United Kingdom, and also to what extent the usefulness of both the American and the British transmissions may be impaired by mutual interference. The frequencies, which are to be maintained within two parts in one hundred million of the nominal values, will be monitored at the National Physical Laboratory, and all inquiries or comments concerning the transmissions should be addressed to the Director, National Physical Laboratory, Teddington, Middlesex. Information about reception conditions and interference with the United States transmissions will be particularly useful.

Centenary of the Royal Meteorological Society

THE centenary of the Royal Meteorological Society falls on April 3, and the following provisional programme in celebration has been arranged. A series of scientific symposia will be held at Christ Church, Oxford, in which a number of eminent foreign meteorologists will participate. The symposia at Oxford will be: March 28 (afternoon), radiation and its effect on the troposphere and lower stratosphere; March 29 (morning), physics of clouds and precipitation; (afternoon), structure of weather systems; March 30 (morning), general circulation of the atmosphere; (afternoon), climatic change; March 31 (morning), meteorology and the community. The meeting at Oxford will terminate with a tour of the city on the afternoon of March 31 and a theatre party in the evening. On April 1 an excursion will be made to the Meteorological Office, Harrow, and at 8 p.m. a conversazione will be held in the Society's Rooms at 49 Cromwell Road, London, S.W.7. A visit to the Department of Meteorology, Imperial College of Science and Technology, will be made on the morning of April 3, and at 3 p.m. the main centenary meeting will take place in the Society's Rooms. In the evening, at 7.45 p.m., the centenary dinner will be held at the Connaught Rooms, London, W.C.1. Accommodation is available at Christ Church, Oxford, and afterwards during April 1–4 at Bedford College, London. To mark the occasion, a special meteorological exhibition is being arranged at the Science Museum, South Kensington, London, S.W.7, and will be open for three months from March 27. Further particulars can be obtained from the Assistant Secretary of the Society.

The Man of Science in Society

DISCUSSING the role of the man of science in society, a writer in the October 1949 issue of *Endeavour* supports the views of those who believe that, outside the laboratory, the personal influence of the man of science should be no more than that of any other citizen, against those who advocate a state verging on a technocracy in which men of science would have special privileges and a large measure of control. Despite his training in scientific method and his ability to store technical information and to interpret it, the man of science is but a link in a long chain and is no more indispensable than other links which support him. There are administrative and economic factors of which the man of science usually knows very little. The majority of men of science—and the informed lay public—feel that science has only limited use in the solution of problems largely influenced by emotional and other imponderable factors. Human problems can only be solved by the accumulated wisdom of responsible laymen who interpret such problems in the light of long and varied experience in human relations and which, until we know vastly more than we do to-day about the working of the human mind, can only be described as intuitive. To make the best use of science there is need for numbers of men of a type which to-day is scarce but not unknown—those who have had a thorough scientific education but have also had considerable experience in practical affairs.

Exchange of Diagrams and Data between Radiation Therapy Centres

THE scheme, organised by the Hospital Physicists' Association, for the exchange of useful diagrams and data between radiotherapy centres is discussed in the *British Journal of Radiology* (February, **23**, 139; 1950). Most centres accumulate isodose and other charts, nomograms, machine drawings and tabulated data, which would often be useful to many other centres, and diagrams in the literature are generally too small to be of practical use, whereas large copies of the originals might be useful. Therefore, catalogues have been issued by the Hospital Physicists' Association, describing all the material available of which copies can be supplied by the honorary secretary of the scheme. Catalogue *A*, issued in December 1944, contained 213 items, and Catalogue *B*, of June 1946, more than two hundred. By the end of 1949 the inquiries about the scheme and requests for catalogues showed no signs of abatement, and about four hundred copies of the first two catalogues had been distributed to all parts of the world. The total number of diagrams, etc., now distributed exceeds 2,500—45 per cent of which have gone outside Great Britain. Within a single recent period of twelve months, nearly nine hundred items were dispatched. The scheme has been run so that it is just self-supporting financially, and costs have been reduced to an average of 3*s*. 2*d*. for a negative copy of a diagram and about 2*s*. for a paper copy of an X-ray isodose chart. The Hospital Physicists' Association will demonstrate the working of the scheme at a stand in the Scientific Exhibition Section of the forthcoming Sixth International Congress of Radiology which will be held in London in July. Catalogue *C*, with 270 items classified

by the system used previously, was issued in December 1949, and copies can be obtained (*5s.*, post free) from the present honorary secretary of the Diagrams and Data Sub-Committee of the Hospital Physicists' Association, D. E. A. Jones, Mount Vernon Hospital, Northwood, Middlesex.

Moa Discoveries

THE Association of Friends of the Canterbury Museum, Christchurch, New Zealand, has produced an interesting guide-book describing how in 1937 moa bones were found at Pyramid Valley, fifty miles from Christchurch, and how the site has since been developed. After two years excavation the total of more or less complete and clearly individual moa skeletons stood at fifty, 17 of them being *Dinornis maximus*, 3 *Pachyornis elephantopus*, 3 *Euryapteryx gravis*, and 27 *Emeus crassus*; these are the heavy-limbed giant grazing moas. In addition to bones were found remains of still undigested meals with recognizable seeds and severed lengths of twigs and coarse grasses, closely packed among the gizzard stones. The few crops examined have revealed no traces of the koromiko (Hebe), the widespread shrub universally associated with the moa in Maori legend. On an average, each gizzard contained 220 stones weighing 5½ lb. These discoveries have been of great assistance in clarifying the systematics of the moas. Copies of the well-illustrated guide may be obtained from the Museum, price *2s. 6d.*

Rock-Shelter Art in South Africa

THE June 1949 issue of the *South African Archæological Bulletin* contains, among other articles, one by the Abbé Henri Breuil on "Some Foreigners in the Frescoes on Rocks in Southern Africa". The Abbé Breuil is convinced that a number of the human beings figured in rock-shelters belong to non-African races, presumably prospectors who came to explore the country. At various periods such prospectors, coming from the north, did penetrate parts of Africa, and we have accounts of them. But whether they really penetrated so far as South Africa is a real problem. The paintings at Impey's Cave certainly recall others found in a rock-shelter in North Africa. But has enough study been given to Bantu art and its possibilities? In this connexion, the studies of Canon Edward Paterson of Cyrene, Southern Rhodesia, who deals with a number of Bantu children, should be mentioned. He maintains that white-man influence has played no part in their drawings, yet these are extremely varied and sometimes quite naturalistic. The same number of the *Bulletin* contains a note, written by A. J. H. Goodwin, of a painted fishing scene from East Griqualand; fishing scenes are none too common in this art. There is also a note by R. J. Mason on some glass implements with Wilton associations.

Scientific Manuscripts from Scandinavia

THROUGHOUT Scandinavia most original scientific work is now published in the English language. Some authors write in English and others have their work translated locally; but in many cases it is advisable to obtain the services of an English-speaking man of science to check the manuscript. A most desirable course would be for such material to be checked by an English-speaking specialist who is working on almost identical lines and thereby has a natural interest in the work. The British Council has, therefore, initiated a scheme whereby it will endeavour to place each manuscript which has been submitted through its offices in Scandinavia with a scientific worker in Great Britain who is likely to have an interest in the subject in question and can carry out the checking. In general, the Scandinavians are willing to pay reasonable fees for such services, and the British Council has arranged to undertake the currency conversion for payment in sterling. The Council itself will make no charge for its services.

East African Industrial Research Board: Report for 1948

THE sixth annual report of the East African Industrial Research Board (pp. 12; Nairobi, 1949; 1*s.* 6*d.*), which became a department of the East African High Commission on January 1, 1948, covers the year ended December 31, 1948. Investigations continued on various branches of ceramic technology, such as bricks and roofing tiles, domestic pottery and refractories, the extraction of undried pyrethrum flowers, the processing of silico-phosphatic fertilizers and the treatment of waste waters from the decortication of sisal. The polluting character of the waste waters and the size of biological filter required to treat them have been considerably reduced by dry decortication of the leaf and then washing the fibre alone. Promising results have been obtained in the treatment of waste waters from processing coffee. A list of technical publications is appended.

"Mercury Tube Effect"

REFERRING to the communication under this title by Dr. J. O'M. Bockris and Dr. R. Parsons in *Nature*, 160, 232 (1947), Prof. William MacNevin, of the Ohio State University, and Earl W. Balis have directed attention to a paper of theirs entitled "Deviations between Observed and Calculated Polarographic Diffusion Currents" (*J. Amer. Chem. Soc.*, 65, 660; 1943). This contains a brief reference to the effect discussed by Messrs. Bockris and Parsons.

Conference on the Older Stone Ages

A CONFERENCE on "The Older Stone Ages: Recent Trends and Discoveries" will be held by the Prehistoric Society, in collaboration with the Institute of Archæology of the University of London, at the latter's address at Inner Circle, Regent's Park, London, N.W.1, during April 14–16. A number of papers will be read, and included in the programme will be discussions on "Geographical Aspects of the Older Palæolithic Cultures", in which Dr. C. McBurney, Mr. M. C. Burkitt, Mr. H. Kelley, Dr. K. Oakley and Mr. A. D. Lacaille will participate, and on "The Origin of the Upper Palæolithic in Europe", which will be introduced by Mr. A. D. Lacaille. Further particulars can be obtained from the London Secretary, Mr. J. W. Brailsford, at the Department of British Antiquities, British Museum, London, W.C.1.

Illuminating Engineering Society: Summer Meeting

THE Illuminating Engineering Society will hold its summer meeting at Buxton, Derbyshire, during May 16–19. The technical papers will all be of a practical nature, and, in addition, two addresses will be given: by Dr. L. A. Sayce, of the Light Division of the National Physical Laboratory, on "Visual Deception"; and by Mr. Ivar Folcker, chairman of the National Illumination Committee of Sweden and president of the Swedish Illuminating Engineering Society, who will speak about lighting in Sweden

during the past ten years. Further details can be obtained from the Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

Aslib Winter Meeting

THE winter meeting of Aslib will be held at the Institution of Electrical Engineers (Savoy Place, London, W.C.2) on March 8, at 5.30 p.m., under the chairmanship of Mr. L. J. F. Brimble. Mr. F. C. Francis, of the British Museum, will speak on "The British National Bibliography", and Mr. W. Cox, of H.M. Stationery Office, on "Government Publications with Special Reference to the Card Index Service". Discussions will follow. The meeting is open to members and guests.

Conference on Mental Health and the Family

A CONFERENCE on "Mental Health and the Family" has been organised by the National Association for Mental Health and will be held at Seymour Hall, Seymour Place, London, W.1, during March 23–24. The conference will be opened by the Archbishop of Canterbury. The topics for the four sessions are: social health in the twentieth century; mental health in young children; education and mental health (childhood and adolescence); on the assumption of maturity. Tickets of admittance (including the printed report) cost 25*s*. and can be obtained from the Conference Secretary, 39 Queen Anne Street, London, W.1.

Conference on World's Food and Britain's Needs

THE Association of Scientific Workers is holding a conference on "The World's Food and Britain's Needs" at St. Pancras Town Hall, Euston Road, London, W.C.1, during March 4–5. Lord Boyd Orr will preside. The conference is designed not merely to direct attention to the urgency of the food problem, but also to show how it can be tackled scientifically. The programme will be divided into three sessions, with speakers and their subjects as follows: Session 1, Dr. Julian S. Huxley, "Population Problems", and Mr. F. Le Gros Clark, "The World's Food Problems"; Session 2, Sir George Stapledon, "Britain's Needs and Possibilities", Dr. G. A. Reay, "Fish Utilization", and Mr. S. A. Barnett, "Prevention of Food Losses"; Session 3, Mr. Ritchie Calder, "Food from Waste Materials", and Lord Boyd Orr, "World Resources and the Distribution of the World's Food". The conference will open with the showing of the documentary film "The World is Rich", by Paul Rotha, and will end with a résumé by Mr. F. Le Gros Clark, entitled "Conference Survey and Future Action". The delegation fee to the conference is 10*s*. per delegate; visitors' tickets are 2*s*. 6*d*. per session, obtainable from the General Secretary, Association of Scientific Workers, 15 Half Moon Street, Piccadilly, London, W.1.

International Congress on Analytical Chemistry

AN International Congress on Analytical Chemistry will be held in Great Britain in 1952. At the meeting of the International Union of Pure and Applied Chemistry in Amsterdam in September, it was decided that six autonomous sections should be formed, one of which would be concerned with analytical chemistry; and it is hoped that a meeting of the board of this provisionally constituted section on analytical chemistry may be arranged to coincide with the Congress in Britain. The honorary secretary of the Congress is Mr. R. C. Chirnside, Research Laboratories of the General Electric Co., Ltd., Wembley, Middlesex.

Nuffield Foundation Awards in Dentistry

To help the advancement of teaching and research on dental health and disease, the Nuffield Foundation is offering a number of fellowships to enable selected men and women with dental qualifications to receive additional training in pure and applied science that will fit them for an academic career in dentistry, and also to enable selected university graduates in medicine and science to receive training that will qualify them to undertake teaching and fundamental research on dental health and disease; in the latter case, however, it is not expected that every fellow will necessarily study to obtain a registerable dental qualification. The annual value of such fellowships is £500–800, and they will be awarded for one to three years. Scholarships, normally tenable for one year, are also available for students at university dental schools in the United Kingdom; these scholarships cover tuition fees and include a subsistence allowance of value not more than £200 a year. Application forms for fellowships must be returned by March 31, and for scholarships by June 30; the forms are obtainable from the Secretary of the Nuffield Foundation, 12 and 13 Mecklenburgh Square, London, W.C.1.

Announcements

M. ANTOINE LACASSAGNE has been elected an *académicien libre* of the Paris Academy of Sciences in succession to the late M. Gustave Roussy.

THE thirty-fourth Guthrie Lecture of the Physical Society will be given by Prof. G. I. Finch at 5 p.m. on March 3 at the Science Museum, Exhibition Road, South Kensington, London, S.W.7. Prof. Finch is the immediate past president of the Physical Society and is well known for his work on electron diffraction. The Lecture, entitled "The Sliding Surface", will be a discussion of the phenomena of wear and lubrication at the sliding surface.

THE following appointments in the University of Manchester have recently been announced: reader in mathematics, M. J. Lighthill; reader in pharmaceutical chemistry, Dr. K. Bullock; senior lecturer in mathematics, G. N. Ward; lecturer in physics, J. A. Newth; lecturer in chemistry, M. C. Whiting.

NEW officers of the British Non-Ferrous Metals Research Association have been elected as follows: the Hon. R. M. Preston, chairman of Council, in succession to Sir John Greenly; Mr. F. C. Braby, vice-chairman and honorary treasurer; and Dr. Maurice Cook, chairman of the Research Board.

APPLICATIONS are invited for Lady Tata Memorial Fund grants and scholarships to scientific workers of any nationality for research in diseases of the blood, with special reference to leukæmia, in the year beginning October 1, 1950. Grants are made for research expenses, and scholarships are awarded as personal remuneration, their normal value being £400 per annum. Applications must be submitted before March 31, and the awards will be announced in June. Further particulars and forms of application may be obtained from the Secretary of the Scientific Advisory Committee, Lady Tata Memorial Fund, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

CHEMISTRY OF FLUORINE

ON November 30 a symposium on fluorine chemistry was held by the Chemical Society at the Royal Institution, London. The choice of this subject is indicative of a rapid growth of interest in both inorganic and organic fluorine compounds. Twenty years ago, elementary fluorine was available in few laboratories and little work on its compounds was in progress. During the war years, however, progress was rapid, particularly in various laboratories in the United States, and the fields opened up then are being more fully explored now. The topics dealt with at the symposium, representing some of the research in progress in Great Britain, were diverse, and for this reason each is separately reviewed below.

Anode phenomena in the production of fluorine (A. J. Rudge). Hitherto, relatively little has been published on the anode phenomena occurring in the medium-temperature fluorine cell, which is the type now commonly used for the laboratory and technical production of the element. It has been found that when potassium fluoride–hydrogen fluoride mixtures containing at least 42 per cent of hydrogen fluoride are electrolysed with a carbon anode, the contact angle between anode and melt is 150–160°. Provided a critical current density is not exceeded, no bubbles of fluorine leave the anode surface. Instead, gas evolution occurs at the electrode/electrolyte/gas space interface. This, and the limited spread of the evolved hydrogen, has the important consequence that no diaphragm need be used in a carbon-anode fluorine cell. Anodic polarization, hitherto a common source of trouble during the generation of fluorine, is influenced by various factors such as the current density, electrolyte composition and its water content and the anode material. With suitable grades of amorphous carbon of high permeability, however, polarization difficulties may be eliminated up to current densities of 1 amp. per square inch, this satisfactory performance being maintained over the whole useful range of electrolyte composition and operating temperature.

Preparation and properties of chlorine trifluoride (R. le G. Burnett and A. A. Banks). Chlorine trifluoride, first prepared on a laboratory scale in 1930 by Ruff and Krug, can now be made and handled on a technical scale. The density, surface tension and parachor have been measured and their implications discussed. Several publications on the controlled reactions of chlorine trifluoride have already appeared in the literature, but it was not realized hitherto that fluorocarbons or even carbon tetrachloride could be used as reaction media. In these media hydrogen in organic compounds is substituted in roughly equal proportions by chlorine and fluorine. Complete replacement of hydrogen is, however, difficult; to take an example, with hydrocarbons containing eight or more carbon atoms in the molecule, about 15 per cent of the hydrogen remains, even with a final reaction temperature of 150°.

Bromine trifluoride as an ionizing solvent (H. J. Emeléus, A. G. Sharpe, A. A. Woolf and V. Gutmann). Pure bromine trifluoride at 25° has a specific conductivity of 8×10^{-3} ohm^{-1} cm.$^{-1}$, the corresponding values for chlorine trifluoride (at 0°) and iodine pentafluoride (at 25°) being $< 10^{-6}$ and $2\text{–}3 \times 10^{-5}$ ohm^{-1} cm.$^{-1}$ respectively. Bromine trifluoride is believed to ionize to a small extent according to the equation $2BrF_3 \rightleftharpoons BrF_2^+ + BrF_4^-$. Adopting the broad definition of acids and bases as compounds which, in a particular solvent, give rise respectively to the cation and anion of the solvent, acids and bases in bromine trifluoride should yield the above ions. The bases $KBrF_4$, $AgBrF_4$ and $Ba(BrF_4)_2$ have, in fact, been prepared by dissolving the corresponding fluorides or other salts of these metals in bromine trifluoride and evaporating excess of the solvent. Similarly, several acids have been isolated (BrF_2SbF_6, $(BrF_2)_2SnF_6$, BrF_2AuF_4, BrF_2NbF_6, BrF_2TaF_6). It is also possible to carry out a conductimetric titration of an acid with a base in this solvent (for example, $AgBrF_4 + BrF_2SbF_6 = AgSbF_6 + 2BrF_3$). The gold acid BrF_2AuF_4 is of special interest because, when heated, it yields the hitherto unknown auric fluoride, AuF_3.

Certain bases (for example, $Ca(BrF_4)_2$) are known to be unstable and to lose bromine trifluoride readily. Similarly, there are probably various unstable acids, the intermediate existence of which can be inferred only from the products of reactions. Potassium metaphosphate, for example, when treated with bromine trifluoride, forms potassium hexafluorophosphate, which is believed to result from a neutralization reaction between the base $KBrF_4$ and the acid BrF_2PF_6. Hexafluoroarsenates are formed rather similarly, and by dissolving silver and bismuth pentafluoride in bromine trifluoride it is possible to prepare silver hexafluorobismuthate. The same principle, involving reactions of the unstable base NO_2BrF_4 (formed from NO_2 and BrF_3), may be used to explain the formation of a number of new derivatives of the NO_2 ion (NO_2BF_4, $(NO_2)_2SnF_6$, NO_2PF_6, NO_2AsF_6, NO_2SbF_6, NO_2AuF_4).

Dissociation energy of the fluorine molecule (M. G. Evans, E. Warhurst and E. Whittle). From a review of available data, it appears that a value of $D(F_2)$ of 33–43 kcal. mol.$^{-1}$, based on recent work by Schmitz and Schumacher and by Wahrhaftig, is more probable than the hitherto accepted value of 63·5 kcal. mol.$^{-1}$ obtained by von Wartenberg. With a value of the dissociation energy in the lower range, the value of the electron affinity of gaseous fluorine must be less than that of chlorine. The electron affinity of fluorine in solution remains, however, larger than that of chlorine, and the conclusions regarding the ionic character of covalent bonds involving fluorine remain unchanged.

During the discussion of this paper, R. F. Barrow presented evidence obtained by a spectroscopic study of cæsium, rubidium and thallous fluorides, which leads to a value of $D(F_2)$ of 45–50 kcal. mol.$^{-1}$, that is again considerably lower than the present standard value.

Rates of reaction of sodium atoms with fluoromethanes (M. G. Evans, E. Warhurst and E. Whittle). The Polanyi sodium-flame technique applied to the series CH_3F, CH_2F_2, CHF_3 and CF_4 leads to some interesting results. A maximum velocity constant is observed for CHF_3, whereas in the corresponding chloro- and bromo-methane series there is a progressive increase from the mono- to the tetra-halide. The two opposing factors influencing the activation energy of these reactions were considered. The first, an increase in resonance energy of the Polanyi–Evans transition state in the series CH_3F to CF_4, causes a steady increase in the rate. This, however, is opposed

by a progressive increase in the C—F bond energy, for which some experimental evidence is now available.

Organic fluorine compounds (M. Stacey). In a general survey of the present position of organic fluorine chemistry, the methods available for the introduction of fluorine into organic compounds were first surveyed. These include the use of reagents such as hydrogen fluoride, antimony trifluoride and other metallic fluorides for the replacement of chlorine, bromine or iodine by fluorine in halohydrocarbons, and the use of fluorides which require elemental fluorine for their preparation. The method of fluorination involving fluorine itself in the presence of a gold- or silver-plated copper catalyst was then considered, and the advantages of the reactive metallic fluorides, such as argentic fluoride or cobalt trifluoride, as agents for the vapour-phase fluorination of organic compounds, were mentioned. It appears probable that this method can be applied under certain conditions to produce fully fluorinated heterocyclic compounds.

A novel polymerization reaction involves the polymerization and simultaneous fluorination of fluorohydrocarbons by fluorine and leads to the formation of stable fluoro-oils. A further interesting development relates to the synthesis of perfluoro adipic acid by the oxidation with potassium permanganate of unsaturated products obtained by the low-temperature fluorination of benzene.

Chemistry of iodotrifluoromethane and iodopentafluoroethane (R. N. Haszeldine and Miss J. Banus). The C—I bond in iodotrifluoromethane breaks heterolytically under certain conditions to give reactions involving a 'positive' iodine atom. Thus with potassium hydroxide, fluoroform and not trifluoromethyl alcohol, together with potassium hypoiodite, is obtained. This reaction has been studied radiochemically in alcohol solution. The homolytic fission of the C—I bond in the fluoroiodides yields fluorocarbon radicals such as CF_3, and these radicals initiate the chain polymerization of olefines. With ethylene, polymers of the type $CF_3[CH_2CH_2]_nI$ ($n = 1$–4) have been synthesized; and from these, trifluorohydrocarbons of the general formula $CF_3(CH_2)_nCH_3$ are obtained; polymers of the type $CF_3[CF_2CF_2]_nI$ ($n = 1$–15) are likewise formed with tetrafluoroethylene. The fluoroiodides obtained from tetrafluoroethylene have also been converted into oils and greases comparable with fluorocarbons in their stability; furthermore, these long-chain fluoroiodides act as sources of long-chain fluorocarbon radicals.

The formation of organometallic compounds from CF_3I and C_2F_5I has been achieved, and the compounds CF_3HgI (and derivatives), $Hg(CF_3)_2$, $As(CF_3)_3$, $As(CF_3)_2I$, $S(CF_3)_2$, $P(CF_3)_3$ and $P(CF_3)_2I$ were described. The properties and reactions of certain of these compounds were considered, and it was evident that they are useful intermediates for the synthesis of other compounds containing fluorocarbon groups. A further interesting reaction involving fluorocarbon radicals led to the synthesis of trifluoropropyne, a compound of great potential synthetic value.

Trifluoroacetic acid and its derivatives (J. C. Tatlow). The methods currently available for the synthesis of trifluoroacetic acid, and some of its reactions, were described. The anhydride of this acid has interesting properties. Hydroxyl groups may be trifluoroacetylated, and the unusual properties of sugar trifluoroacetates were revealed. They are unstable compared with normal acetates and are readily hydrolysed by moisture; ethyl alcohol causes alcoholysis to the parent sugar. Since the trifluoroacetyl group is not removed during subsequent tosylation or acetylation reactions in pyridine solution, however, the trifluoroacetyl group may prove to be of use as a 'blocking' group in carbohydrate chemistry.

A mixture of acetic acid and trifluoroacetic anhydride gives sugar and alcohol acetates in good yield; even cellulose may be acetylated successfully by this method. It is of interest to note that amines form the trifluoroacetyl derivative, and not the acetyl derivative, when treated with a carboxylic acid and trifluoroacetic anhydride.

With nitric acid, trifluoroacetic anhydride forms an active nitrating mixture, and excellent yields of the nitro derivatives of nitrobenzene, benzonitrile and bromobenzene may be obtained; it appears likely that even aliphatic nitration may occur under mild conditions. The value of trifluoroacetic acid in synthetic organic fluorine chemistry is apparent.

H. J. Emeléus

HORMONE ASSAYS

A SYMPOSIUM on "Hormone Assays" was held on October 20 in London, organised jointly by the Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists and by the Society for Endocrinology. Seven papers were read, dealing with the assay of insulin, posterior pituitary, gonadotrophins, thyroid, œstrogens (in man), and with general principles of bioassay. The Biological Methods Group is to be congratulated on its enterprise. Previous symposia organised by the Group have dealt with penicillin assay, the assay of curare and curare-mimetic substances, the evaluation of selective weed-killers and other bioassay problems of general interest. These discussions are, as a rule, published in full in the *Analyst*. A shortened abstract of the present meeting will also be published in the *Journal of Endocrinology*.

Although certain hormones may be detected by colorimetric or other chemical reactions, in most cases these are not sensitive enough, and bioassay methods are required. Hormone assays are often conducted without proper regard for the principles of biological assay, and much of the discussion at the meeting was devoted to reconsidering these principles as they apply to hormone assays. In general, bioassays are of two kinds: those in which standard and unknown differ quantitatively, and those in which they differ qualitatively. Assays of the first kind have the same object as chemical determinations, and they are used only where no adequate chemical methods are available. The design of these assays has been greatly improved during the past few years, and they can now be rendered extremely accurate. Particularly satisfactory are those assays in which, as in the standardization of insulin, standard and unknown can be relied upon to be pure and have the same chemical composition. Assays of mixed and impure extracts, such as the assay of sex hormones or gonadotrophins in urine, are rather less satisfactory. In these cases more than one active principle is usually present, and there is the danger that the unknown solution may be assayed in terms of a standard of different composition. Prof. J. H. Gaddum discussed some of the difficulties arising in the interpretation of these assays.

Experiments in which the biological actions of different chemical substances are compared are not always classified as bioassays, but there is no reason why they should be excluded. In practice, they are of the greatest importance, since all preparative pharmacology—the preparation and the determination of activity of new substances—is based on this type of assay. Dr. P. M. F. Bishop's paper showed that such assays can be performed in man and can give consistent results. It must be realized, however, that when different chemical substances are compared, the result of the assay depends on the method, end-point and species used, and any comparative figure is valid only for particular circumstances.

Prof. J. H. Gaddum (University of Edinburgh), the chairman, said that the reason why certain substances are assayed by biological methods is that some drugs, such as insulin, cannot be controlled in any other way, and some drugs, such as acetylcholine, are commonly present in concentrations which are too low to be detected in any other way. Analysts are interested in accuracy and endocrinologists in discovering new facts. The object of the meeting was that endocrinologists should learn accuracy and that analysts should learn something of the difficulties of the endocrinologists. Bioassays should be based on the following principles: each assay should consist of a comparison between an unknown preparation and a standard one; each of these preparations should contain the same single active principle and no other substance which modifies its action in the test; each assay should be complete in itself and should involve no arbitrary assumptions about such things as the slope or even the shape of the dose-effect curve, and the limits of the error should be calculated from the internal evidence of each assay.

It is quite impossible to attach any real meaning to the results of assays of unknown mixtures of œstrogens. Estimates which purport to give 'œstrogenic activity' of such mixtures are liable to vary over a thirty-fold range or more, according to the way the test is done. The only possible way of getting results with any intelligible meaning in bioassays of mixtures of œstrogens seems to depend on removing the interfering substances and separating the œstrogens from one another before the biological tests are made. There can be no justification for speaking, as some still do, of 'mouse units' of chorionic gonadotrophin. An international standard preparation of this substance is available, and results should be given in international units. Apart from the provision of reliable preparations of hormones, the contribution which bioassays can make to clinical endocrinology depends on the estimation of hormones in blood and urine. The concentration in the urine may provide an indirect estimate of the daily output of hormone. If, for example, it is found that when a hormone is injected 5 per cent of it appears in the urine, it may be justifiable to make the provisional assumption that the daily output by the gland is equal to the amount excreted in the urine multiplied by twenty. The time will probably come when provision for assays of this kind will be an essential part of the equipment of all large hospitals. The discovery of more sensitive methods is an important objective; at present only chorionic gonadotrophin is present in sufficient concentration to be accurately estimated in both blood and urine.

Dr. H. O. Schild (University College, London) said that digitalis and posterior pituitary are examples of mixed extracts of undefined composition, in which standardization in animals might be misleading. Should these extracts be standardized in man? Even if the technical difficulties could be completely overcome, there would remain the objection that activity ratios as found in one man and one disease might not apply to others. The problem of standardizing accurately, for human use, mixed extracts containing several related pharmacological principles is essentially insoluble; but animal standardizations may be regarded as a useful safeguard against worthless preparations.

Statistics have immensely improved the planning and interpretation of biological assays. The old non-statistical methods have, however, not been completely superseded. For example, the old 'bracketing' method, by which standard and unknown are matched by trial and error, is still widely used in research work. This has some justification, since the method involves no assumptions of a mathematical relation between dose and effect. On the other hand, most statistical methods involve some such assumption and for that very reason are subject to certain fallacies.

The measurement of thyroidal activity was discussed by Dr. G. F. Somers (Glaxo Laboratories, Greenford). At present the official British Pharmacopœia method of standardization is based on an estimation of acid-insoluble organically combined (thyroxine) iodine. The United States Pharmacopeia makes use of the total iodine content present in thyroid combination. The British Pharmacopœia method is probably satisfactory for thyroid preparations, but is unsatisfactory for the assay of artificially iodinated proteins and for evaluating the thyroidal activity of thyroxine analogues. For this purpose, biological methods must be used. These are commonly based on the following reactions: (1) changes in respiratory metabolism; (2) decreased susceptibility to anoxia; (3) loss in body-weight; (4) decrease in susceptibility to toxic substances; (5) premature metamorphic changes in amphibians; (6) restoration and maintenance of growth in thyroidectomized rats; (7) antagonism to goitrogenic drugs. Using the first method, the following relative activities of thyroxine derivatives were obtained: *dl*-thyroxine sodium (standard), 1·0; thyroxine methyl ester, 0·65; thyroxine ethyl ester, 0·51; N-formyl thyroxine, 0·33; *l*-thyroxine sodium, 1·95. These figures cannot give a true index of the activity for man, which can only be settled by clinical trial. Dr. Rosalind Pitt Rivers said there is evidence that *d*-thyroxine is active when tested on myxœdema patients; it has 1/8 to 1/10 the activity of *l*-thyroxine.

Dr. J. A. Loraine (University of Edinburgh) said that the anterior lobe of the pituitary produces at least three gonadotrophic hormones. These are the follicle-stimulating hormone, the luteinizing hormone and luteotrophin. In addition, there are two important gonadotrophins: chorionic gonadotrophin elaborated by the human placenta with predominantly luteinizing action, and pregnant mares serum gonadotrophin, which is predominantly follicle-stimulating. Animal tests for the assay of chorionic gonadotrophin may be divided into primary and secondary, according to whether the organs inspected are the gonads themselves or organs affected secondarily by the liberation of œstrogens or androgens from the gonads. The primary tests register effects on corpora lutea, ovarian weight, ovarian hyperæmia in rats, rabbit ovulation and xenopus; the secondary tests on uterine weight, vaginal smears,

vaginal smears in B-deficient rats, seminal vesicles and prostatic weight. Dr. Loraine has found the assay depending on prostatic weight to be convenient and sensitive. An advantage of this test is that the œstrogens normally present in pregnancy urine do not interfere with the assay. By this method 20,000–40,000 I.U. of chorionic gonadotrophin appeared to be excreted in twenty-four hours from the fortieth to eightieth day of pregnancy and less than 10,000 I.U. after the third month. The estimation of gonadotrophins in the urine of men, non-pregnant women and children is at present unsatisfactory. Dr. Annie M. Hain (Manchester) and Dr. G. I. M. Swyer (London) discussed the production of gonadotrophins in testicular tumours. These may be derived from two sources, the patient's anterior pituitary and the tumour.

In discussing the assay of insulin, Mr. K. L. Smith (Boots, Ltd., Nottingham) said that this is done either by a fall in blood sugar in rabbits or by the incidence of convulsions in mice. The accuracy of the mouse method is such that the use of some eight hundred mice should give an estimate accurate to ± 10 per cent at $P = 0{\cdot}95$. It would require 240 rabbit responses to obtain the same accuracy by the blood-sugar method.

The assay of posterior pituitary lobe extracts was considered by Mr. G. A. Stewart (Wellcome Laboratories, Dartford). The oxytocic principle is usually assayed by the guinea-pig test *in vitro*; but this assay may be misleading since the guinea-pig uterus reacts also to vasopressin. Moreover, the sensitivity to vasopressin varies according to the hormonal state of the uterus and the magnesium concentration of the solution. Oxytocin may be satisfactorily assayed by the fall of blood pressure produced in chickens; this test is not normally affected by vasopressin.

Miss M. H. I. Macauley mentioned the anæsthetized rat method for assaying vasopressin, which is found to be sensitive, specific and discriminating.

The clinical methods of assaying œstrogens were discussed by Dr. P. M. F. Bishop (Chelsea Hospital, London). When the stilbene group of synthetic œstrogens was introduced by Dodds and his co-workers, their relative potency was tested on the vaginal smear changes of castrated rats and mice. Hexœstrol and dienœstrol were found by these tests to be more potent than stilbœstrol. Clinical experience soon gave rise to the impression that these ratios of potency might not hold good in the human subject. In trying to compare these drugs in man, the following end-points were submitted to scrutiny: (1) the hot flush count in menopausal women; (2) the vaginal smear in menopausal women; (3) the induction of œstrogen-withdrawal bleeding. Only the third proved a practicable assay method. The general plan was that 2 mgm. stilbœstrol were administered daily by mouth for a fortnight to chosen cases of amenorrhœa. Depending on whether œstrogen-withdrawal bleeding took place or failed to do so, the dose was lowered to 1 mgm. or increased to 3 mgm. daily for fourteen days. The mean of the two doses which just failed and just succeeded was taken as the therapeutic unit. In the same patient a therapeutic unit for another œstrogen was then established.

A thousand courses of œstrogen have been administered, and the results are remarkably consistent. Dienœstrol was found to be about a quarter, and hexœstrol about an eighteenth, as potent as stilbœstrol. It should be emphasized that these ratios of œstrogenic potency only apply to women in the age-group of maturity, suffering from amenorrhœa. There is no guarantee that the same ratios would hold, for example, for the response to œstrogens of women of menopausal age or of men with prostatic carcinoma.

Dr. W. A. Broom (Nottingham) said that the results of his assays in rats on stilbœstrol, hexœstrol and dienœstrol agree well with Dr. Bishop's clinical results. However, with ethinyl œstradiol the agreement ceases, since in rats this substance is five times less active than stilbœstrol, while clinically it is 100–200 times more active.

H. O. SCHILD

IRRADIATION OF MIXED TISSUES

By DR. W. H. LOVE

Department of Physics, University of Sydney

AN examination of the various researches that have been made into the quantitative effects of radiations on cells and tissues shows that the relationship between q, the radiation dose, and P, the proportion of cells of a given type T_1 that survive the dose q, is represented by a sigmoid curve A_1 (Fig. 1).

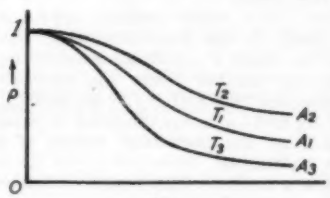

Fig. 1

If cells of type T_2 are less 'radio-sensitive' than those of type T_1, and if cells of type T_3 are more sensitive than those of type T_1, then it seems to have been generally assumed that the survival curve A_2 for type T_2 will be everywhere above A_1 and that the survival curve A_3 for type T_3 will be everywhere below A_1.

The object of the present communication is two-fold: (i) to show that the curves may cross, and (ii) to pursue some of the immediate consequences of (i).

If a tissue of given type is acted upon by radiation of a given quality, it is known that the fractional survival P, associated with a dose q, is determined by $fn(\lambda q)$, the first $n + 1$ terms of the Poisson series in λq, where n and λ are characteristic of the tissue and the quality of the radiation.

Let A_1 (Fig. 2) be the survival curve for tissue T_1 characterized by n_1 and λ_1, and let A_2 be the survival curve for tissue T_2 characterized by n_2 and λ_2. Then if $n_2 > n_1$ and $\lambda_2 < \lambda_1$ the curve A_2 will be everywhere above A_1 and the survivals will be determined by:

$$P_1 = fn_1(\lambda_1 q),\ P_2 = fn_2(\lambda_2 q).$$

Consider now a third tissue T_3 the cells of which are characterized by n_3 and λ_3, and suppose that λ_3/λ_2 is some proper fraction equal, for example, to the ratio q_2/q_1. Then its survival curve A_3 will be determined by:

$$P_3 = fn_3\left(\lambda_3 \frac{q_2}{q_1} q\right),$$

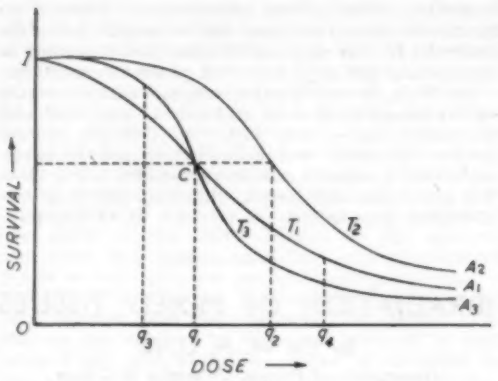

Fig. 2

and it may be obtained from that of T_2 by reducing all the abscisse of T_2 in the ratio q_1/q_2.

In this particular case the point C will be common to each of the curves A_1 and A_2, and it can be shown both analytically and graphically that the curves cross at this point.

Adoption of a more general approach to the problem leads to the conclusion that the survival curve for one tissue T_A, characterized by n_A, λ_A, will cross that for another tissue T_B, characterized by n_B, λ_B, provided that: (i) $n_A > n_B$ and $\lambda_A > \lambda_B$, or (ii) $n_A < n_B$ and $\lambda_B > \lambda_A$, the point of crossing being determined by the particular values of the characteristic quantities.

It is now a matter of interest to examine some of the consequences of this result.

Consider the conclusions that may be drawn by three observers each of whom set out independently to measure the relative sensitivities of the tissues T_1 and T_2 by comparing the relative survivals P_1 and P_2 associated with some particular dose q. If the first observer operated in the region $0 < q < q_1$, he would conclude that tissue T_1 was more sensitive than T_2; if the second observer operated in the region $q > q_1$, he would arrive at the opposite conclusion; and if the third observer chose to administer a dose in the immediate vicinity of q_1, he would find that the tissues were equally sensitive. Each would be correct within the limits imposed by the conditions of his experiment, and it becomes apparent that conclusions based on isolated observations of this kind could be misleading to the observers both individually and collectively.

Suppose now that each of the first two experiments were performed by the one observer who administered a dose $q < q_1$ to one sample of the tissues T_1 and T_2, and then a dose $q > q_1$ to another sample of the same tissues. He would become aware of an apparent 'reversal' of the sensitivities. If he had used the one sample of tissues in both experiments, so that the first irradiation of the sample was afterwards followed by a second irradiation of the same sample, he might assume that his results justified the conclusion that the resistance of the tissue T_1 had been enhanced by the initial treatment.

The fractionation technique in which a given total dose is administered in a number of fractional doses assumes a particular significance when we consider its bearing on the question of survival in tissues the survival curves of which are related like those for T_1 and T_2. Let us assume that our aim is the achievement of an end result in which the minimum survival in T_1 is accompanied by a maximum differential effect between T_1 and T_2, subject to the condition that the survival in T_2 is greater than that in T_1.

Reference to Fig. 2 shows that the appropriate fractional dose in the circumstances is one in the vicinity of q_3. The differential effect associated with the dose q_1 is zero; that associated with a dose in the neighbourhood of q_4 may be substantial but the prescribed condition is not satisfied.

In the radiotherapeutic treatment of malignant conditions a beam of radiation is directed on to a composite structure in which malignant cells of one type are embedded in a tissue composed of cells of another type, and the possible crossing of the associated survival curves assumes a distinct practical significance.

POSITIVE IONS IN GAS DISCHARGES

By R. L. F. BOYD

Department of Mathematics, University College, London

THE treatment of the ions in the positive column of a glow discharge as though they had a Maxwellian velocity distribution, giving a current density to a strongly negative probe equal to the random ion current-density in the plasma, is frequently inconsistent with 'Langmuir' probe measurements, which on this theory would lead to the untenable conclusion that the positive ions had a temperature equal to or greater than that of the electrons[1]. In order to elucidate this anomaly and to obtain experimental data on the positive ion energies, experiments have been carried out on the positive column of a 7-cm. diameter hot-cathode glow discharge in argon, using a plane Langmuir probe screened with a very fine wire grid (14 strands of 0·016 mm. tungsten across a 1-mm. diameter hole). The grid was made using the hydrogen atmosphere brazing technique employed in the manufacture of planar triodes. The probe construction is shown in Fig. 1.

By using this electrode system as a Langmuir probe and making the collector behind the grid alternately strongly positive and strongly negative, it has been possible to separate the Langmuir probe characteristic into its negative and positive components, secondary emission from the collector by neutral particles being shown as a saturation minimum to the positive ion component. One such curve is shown in Fig. 2. Previous attempts[2,3] have been made to use grids or perforated electrodes to split the characteristic into its two components; but the electrode assemblies being large, it was necessary

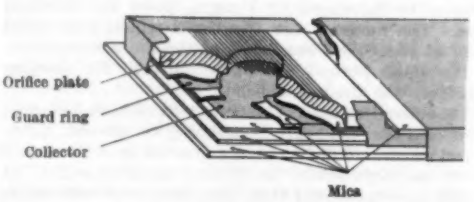

Fig. 1. Screened probe

always to maintain the grid at a potential negative to the space in order to prevent it from becoming the anode. The analysis of the positive ion energies was carried out using retardation by the collector after the initial acceleration of the ions by the field in front of the grid. Unfortunately, however, this method does not give a result characteristic of the discharge, for reasons which will now be given.

A consideration of the mechanism of sheath formation in electropositive gases has led to the conclusion that, for a localized positive ion sheath to form on a plane negative electrode, the distribution function $f(E)$ of the energies associated with the components of the positive ion velocities normal to the sheath edge must comply with the condition

$$\frac{2\int_0^\infty f(E).\,E^{1/2}.\,dE}{\int_0^\infty f(E).\,E^{-1/2}.\,dE} > V_e.$$

($V_e = kT/e$, where T is the electron temperature and k is Boltzmann's constant.) Unless this condition is satisfied the positive ion current will not become saturated, and the field from the probe will penetrate into the plasma. The penetration of this field modifies the energy distribution and the concentration of the positive ions in the probe neighbourhood until, if the probe voltage is sufficient, the condition is satisfied and the sheath forms.

By using a very small electrode assembly, it has been possible to measure the energy distribution of the ions by varying the grid potential, so that the distribution is undisturbed by a penetrating field.

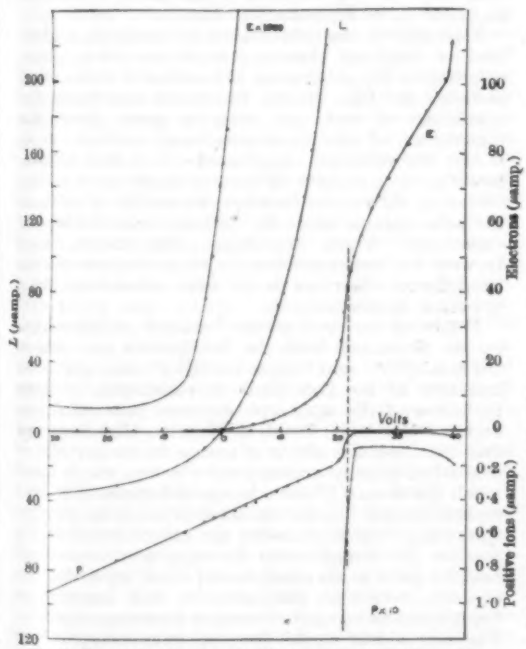

Fig. 2. Screened probe characteristic in argon at 0·0009 mm. Hg. at 100 m.amp. tube current. *L*, Langmuir curve; *E*, electron component; *P*, positive ion component

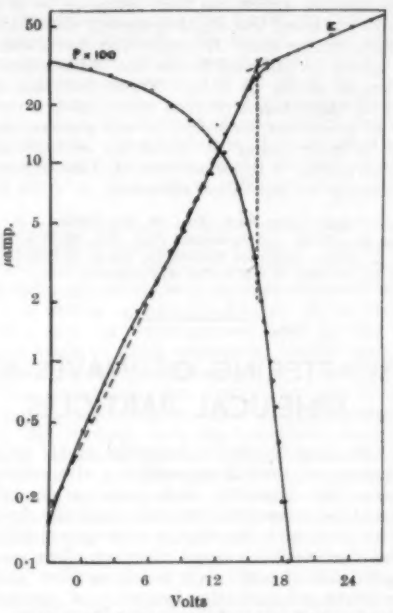

Fig. 3. Semi-logarithmic plots of electron and positive ion current to the screened probe, in argon at 0·004 mm. Hg. at 100 m.amp. tube current

By making the reasonable assumption that the predominant collision process in the mobility mechanism for the ions is charge exchange (so that each ion starts almost from rest after making a collision[4]), expressions have been obtained for the probe voltage ΔV necessary to cause positive ion saturation, and for the ratio of the saturation probe current for idealized high-pressure and low-pressure cases (order of 1 mm. and 10^{-3} mm. mercury respectively). They are given in the accompanying table.

	High pressure	Low pressure
ΔV	$\frac{V_e}{2}\log\left\{\frac{V_e}{\beta}\cdot\left(\frac{\mu}{v_+}\right)^2\right\}$	$0{\cdot}7\ V_e$
(I_e/I_+)	$\frac{1{\cdot}62\times10^7}{v_+}\ V_e^{1/2}$	$1{\cdot}04\left(\frac{M_+}{M_e}\right)^{1/2}$

β = Mean free path (charge exchange) × pressure (cm. × mm. mercury). v_+ = mean normal component of positive ion velocities. μ = Sena's mobility constant. (Practical units are used.)

Reference to Fig. 3, which gives the semilogarithmic graph of the positive ion and electron-probe currents in an argon discharge at 0·004 mm. mercury, shows clearly that the positive ion saturation does not occur until the probe is about 3 volts negative to the space potential. The calculated value of ΔV for this case is 2·7 volts. Curves taken for various probe orientations show that the positive ion velocity-distribution is very anisotropic, and also that at pressures both above and below 0·004 mm. mercury the mean positive ion energy is less than at this pressure. At the pressure for the curves shown, the positive ion 'temperature' determined from the slope of the curve is about 0·3 of the electron temperature. At a pressure of 0·75 mm. mercury it was approximately gas kinetic, while at 0·0009 mm. mercury it was about 0·1 of the electron temperature.

The screened probe has been found to be of special value in studying the electron-energy distribution at the high-energy end. In argon the distribution has been found to fall well below the Maxwellian value at energies above 15 volts. These facts are of considerable importance in the study of the reaction-rates of processes occurring in the plasma, and the study is now being extended to include electro-negative gases. A fuller account of these experiments will shortly be published elsewhere.

[1] Langmuir and Tonks, *Phys. Rev.*, **34**, 876 (1929).
[2] Tonks, Mott-Smith and Langmuir, *Phys. Rev.*, **28**, 104 (1926).
[3] Sena, L., *Trans. All-Union Electrotechn. Assoc.*, 42 (1935).
[4] Sena, L., *J. Phys. U.S.S.R.*, **10**, 179 (1936).

SCATTERING OF WAVES BY SPHERICAL PARTICLES

EVER since Tyndall's beautiful series of experiments in 1868 demonstrating the relationship between the intensity and polarization of light scattered by suspended particles and the density of the particles, and Rayleigh's subsequent deduction, on the elastic solid concept of æther vibration, that for particles of size very much smaller than the wave-length of light the intensity of scattering is proportional to the inverse fourth power of the wave-length, much interest, both theoretical and experimental, has been taken in this phenomenon of scattering. In 1908, the first rigorous treatment, according to the methods of electromagnetic theory, of the complete diffraction of a plane wave by a spherical particle of any composition was given by Gustav Mie, and this has become the classic contribution to the subject upon which subsequent discussions have been based.

Several years ago the Computation Laboratory of the United States National Bureau of Standards applied the Mie theory to compute extensive tables of scattering functions for both real and complex values of the index of refraction of spherical particles, and these have recently been published*.

The various intensity functions, which are listed, give the angular distribution of intensity and the total light scattered as a function of $\alpha = 2\pi r/\lambda$, where r is the radius of the small spherical particle from which the light is scattered; r is approximately equal to λ, the wave-length of the incident light. From the angular distribution and the total light scattered by a suspension of particles of uniform size, the particle-size and concentration can be deduced, and the method of deduction is described. The tables are divided into four sections, the first three of which relate to real indices of refraction m, and the fourth to certain complex indices. In Part 1 the angular distribution functions, proportional to the intensities of the two incoherent, plane-polarized components scattered by a transparent particle illuminated with natural light, for values of m between 1·33 and 2·00, and in Part 2 the total scattering coefficient, for $m = 1{\cdot}50$, are tabled. From Part 3 the total scattering (and absorbing) coefficient can be obtained for absorbing materials of extinction coefficient varying between 0 and 0·1 and of m between 1·44 and 1·55.

* U.S. Department of Commerce: National Bureau of Standards. Applied Mathematical Series 4: Tables of Scattering Functions for Spherical Particles. Pp. 119. (Washington, D.C.: Government Printing Office, 1948.) 45 cents.

The sets of tables for real m were computed originally on the recommendation of Prof. V. K. La Mer, professor of chemistry at Columbia University, and arose out of a series of investigations relating to chemical warfare. In Part 4 the tables have been extended to certain values of complex arguments and have application in microwave radar, where the echoes received on radar sets from suspended or falling water-droplets in the atmosphere are a particular case of the scattering problem. The range of wave-length thus considered is 10 cm.–3 mm., and the dispersion measurements made by Dr. J. A. Saxton, of the National Physical Laboratory, are used.

An admirable foreword to the tables is contributed by Prof. J. A. Stratton, who briefly reviews the history of the problem of scattering, describes Mie's formal solution, the method by which the tables have been compiled, and their particular applications. Confidence is expressed that the tables will be of considerable benefit to physical and biological science. Mathematical definitions of the tabulated functions, as well as the physical significance of the tabulated quantities, together with a short bibliography, are given in the introduction. The tables themselves are clear and easy to read, though the size and spacing of the numbers in the tables vary almost from page to page. The paper cover is to be deplored.

S. WEINTROUB

REPEATABILITY OF TEST RESULTS

A RECENT meeting of the London Group of the Royal Statistical Society's Industrial Applications Section was devoted to a discussion of the difficulties arising from discrepancies in what are supposed to be replicate test results.

Especially in the field of chemical analysis, a great deal of empirical standardization has taken place, resulting in the publication of handbooks of standard methods of tests. These, by closely specifying the conditions of test and even in some cases the dimensions of the apparatus used, endeavour to reduce the variation experienced. It is well known, however, that in spite of these attempts at reducing variation, differences between the results of tests on the same sample made by different laboratories are experienced which are larger than those found between replicate results of the same observer or even by different observers in the same laboratory using the same apparatus.

Following the lead of the Institute of Petroleum in its Standard Methods Handbook, the names 'repeatability' and 'reproducibility' are given to measures of the two kinds of variability, between replicates of the same operator and between laboratories. Mr. A. H. Dodd, of Newton, Chambers and Co., criticized this choice of names on the grounds of confusion, since in ordinary use the two words mean much the same. If there is any difference, it is that reproducibility implies an attempt to make two results alike, thus introducing the suggestion of faking results. He thought that the coining of new words (and he gave as an example the word 'squariate' for squared deviation) preferable, in this instance at least, to the twisting of old ones to bear new meanings. The new words would be even more acceptable if they conveyed within themselves the ideas of these two separate sources of variation.

Mr. J. R. Fraser, Government Chemist's Laboratory, discussed an analysis by the late Dr. Tocher of 356 test results, obtained from ten different laboratories and involving thirty-five different operators, on portions of the same material. A previously held suspicion that results from different laboratories would be significantly different was confirmed. The report makes no attempt to distinguish the two kinds of variability, but directs the attention of analysts to the need to avoid local techniques. It is, in other words, a plea for the standardization which is now being brought about. Mr. Fraser made the point that, while it is necessary to recognize and to measure the two kinds of variation, a method of test cannot be regarded as good until the two are equal; that is, the replication of a test in another laboratory should be subject to the same variability as one by the same operator. He also stressed the fact that good replication cannot be taken to indicate the correctness of the result.

After reviewing former procedure, Mr. G. Claxton, of the National Benzol Co., pointed out how the work of the Standardization of Tar Products Tests Committee and similar bodies has considerably reduced the disagreement which formerly existed between laboratories. The discrepancies have been reduced, but not completely to the level of the repeatability that a single operator can achieve. It is necessary to have some measure of each of the sources of variability in order, first, that an operator may know that his technique and apparatus are reasonably good, since departure in either respect presumably leads to greater variability among his own replicates; and, second, in order that due weight may be given to discrepancies between the test results of different laboratories.

When, in drawing up specifications, an attempt is made to allow for discrepancies between laboratories, difficulties arise. Mr. Claxton illustrated this by reference to one particular test, that for the sulphur-content of motor benzol, usually specified to be not more than 0·4 per cent by weight. The usual procedure is that the maker, having collected a bulk for dispatch, draws a sample, of which one portion is sent to a central laboratory and the other tested in his own laboratory. These two portions will be almost identical in sulphur-content, even though owing to difficulties in sampling they do not truly represent the average of the batch. If the tests on the two portions agree that the specification is complied with, both buyer and seller are satisfied. If not, and after a second test they still do not agree, the buyer may call for a sample and test it himself. This sample, because it is separately drawn from the bulk, may differ from the previous one in its true sulphur-content. Thus, in addition to the so-called repeatability and reproducibility, a third source of variation may enter into the specification, namely, the variability of samples drawn from the same bulk.

By means of a diagram, Mr. Claxton explained how these sources of variation can operate to cause a batch to be accepted which is actually above specification in sulphur-content. He showed that the logical way of dealing with this is to achieve some measure of these variabilities and to set an arbitrary specification-limit lower than the actual tolerable maximum, thus ensuring that, even when the variability operates unfavourably, bulks above the tolerable maximum sulphur-content are rarely accepted. The Standardization of Tar Products Tests Committee is in process of making these measures of repeatability and reproducibility; but its figures have to be based on only a few results and are thought to be unnecessarily high. He entered a plea that the thousands of tests which are made annually in the routine of business might be modified so that by statistical analysis the estimates of variability might be extracted. This method of collecting information would have the advantage that the operators would not be tempted to spoil the estimates by taking special care, as they might with specially arranged tests.

Mr. R. G. Newton, of the British Rubber Producers' Research Association, spoke of the difficulty in rubber testing of achieving standard conditions of test, a difficulty which leads to high values of repeatability as well as of reproducibility. He quoted the case of a test for which repeat tests by the same operator made in quick succession varied more than tests made on different occasions. In this particular case the variability was traced to the effect of warming up the machine in which the rubber was mixed. Mr. Newton drew the conclusion that where so many causes of great variability exist, it is important to identify each and to estimate the variation to be attributed to each. Repeatability and reproducibility are all-embracing terms and are not sufficient in the case of rubber testing.

A routine analysis during production was discussed by Mr. A. E. Worley and Mr. C. E. Rhodes, of Reckitt and Colman, Ltd. They have found it necessary to employ several operators and to devise a routine of analysis which is quicker than ordinary standard methods and yet does not invite any lowering of standards of care on the part of the operator. Their methods have some originality, especially in their application to the chemical field, in that they first determined tolerable limits for the result of a test on an acceptable batch of products, and then adjusted the 'accuracy' of the test, relaxing where possible, so that batches of the product would be wrongly accepted only very rarely. This relaxing of accuracy effectively divides the presented batches into only three kinds: those below the tolerable lower limit for the test result, those within the tolerable limits and those above the higher tolerable limit.

This procedure can be thought of as equivalent to the engineer's use of a go-and-not-go gauge. By studying and measuring the various sources of variability in the test procedure, they were able to eliminate most of the variability between operators and to adjust the total effect of the other sources of variability to produce the required degree of accuracy. Their adjustment took the form, for example, of an alteration in the amount or strength of titrating fluid delivered by an auto-pipette. The important point is that the relaxation was not achieved by allowing slipshod methods, but only by broadening the classifications used to express the results. The relaxation is, as it were, under control and was only achieved after a study of the magnitudes of the various sources of variation. The authors of the scheme estimate that by its use they have achieved a reduction in the time taken for one test from five minutes to half a minute.

In the discussion, members of the audience were agreed that statistical analysis provides a useful means of interpreting the various sources of variation experienced in test results of all kinds, and that the estimation of the magnitudes to be attributed to the various sources (or groups of sources) is of value in control and interpretation. E. D. VAN REST

THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THE report of the Chemistry Research Board for 1948, issued with the report of the Director of the Chemical Research Laboratory under the title "Chemistry Research 1948"*, like the report for 1938–46, which appeared last year, refers to both the long-term and the short-term aspects of the work of the Laboratory. After considering an important paper from the Director on the functions and future policy of the Laboratory, the Board decided to recommend that the general functions of the Laboratory should be: (*a*) to carry out objective fundamental chemical research including developmental work so far as this may be necessary to establish the industrial value of any discoveries which may be made; (*b*) to carry out appropriate chemical research on request and to provide technical advice to other sections of the Department of Scientific and Industrial Research, other government departments and British industry.

The Board thinks it appropriate that the work of a national research establishment should have this dual nature, but that a proper balance must be preserved between the two aspects. Mindful possibly of comments from the Select Committee on Estimates in regard to expenditure on research and development, the Board emphasizes that careful selection of topics in the programme of fundamental research is essential. Detailed consideration of the general policy which should determine the choice leads it to the opinion that long-range problems of chemistry or chemical technology, of a type which require attack by a skilled team over a long period, should be studied. The work should not duplicate that proceeding in British universities and industry, although duplication may not always be avoidable.

Five main themes are considered particularly appropriate for inclusion in the future programme of the Laboratory. First of these are researches leading to fundamental reference data of general value, such as precise data on the fundamental constants of pure chemical compounds. Second come new methods and techniques of chemistry in which it is desirable that an expert group should be maintained, particularly those which are so difficult or expensive as to be beyond the range of small research units. The Board recommended in 1944 that the Laboratory should pay particular attention to new techniques in its post-war programme, and subsequent developments have shown that this is one of the most useful fields in which the Laboratory can work. Next, the conservation of essential materials is recommended, with the objective of husbanding material resources, particularly key materials. Related to this is the utilization of indigenous raw materials, especially those of low grade, including wastes. The basic problems here are often technically difficult and demand long-term efforts for their solution. The main example of such work is to be found in that going forward at the Laboratory for the Ministry of Supply. Lastly, the investigation of potentially interesting new processes and materials is recommended.

The establishment of a Pure Metals Committee to stimulate interest in and co-ordinate the preparation of pure metals for research and development, and of a High Polymers Committee, under the chairmanship of Prof. H. W. Melville, in July 1948, are in line with these main themes. The Board, however, also undertook during the year a special review of current activities to ensure that the resources of the Laboratory were being applied in the most effective manner, having regard to the present national situation. It is agreed that it is necessary at present to ensure that every effort is made to apply scientific knowledge effectively, and that all possible help is given in the solution of current practical problems of importance in industry and government departments; but anxiety is expressed lest the fundamental research of the Laboratory may suffer in consequence.

In consequence of this change of plan, advisory and liaison work has increased in all sections, while in the re-organisation of the organic chemistry research of the Laboratory, the Coal Tar Section, which was one of the first major sections, has ceased to exist. In the re-orientation a prominent place has been assigned to the accurate determination of physical and physico-chemical data for pure organic compounds, and the Laboratory is developing its contact with the Hydrocarbon Research Group of the Institute of Petroleum. Prominence has also been given to investigations on the insecticidal properties of compounds derived from coal tar bases, the evaluation and development of acenaphthylene polymers and co-polymers, and new analytical procedures for certain coal-tar compounds. A programme of work has been initiated on the preparation of isotopically labelled organic compounds; thus far the emphasis has been on the stable isotopes, and special procedures necessary for the manipulation and synthesis on the micro-scale of labelled compounds and simple intermediates containing carbon-13 have been evolved.

The Board refers particularly to the striking advances made at the Laboratory in the chromatographic separation of inorganic materials by a new technique involving the use of cellulose and other absorbing materials on one hand and of organic solvents containing additional reagents on the other, as well as to the concentration of effort by the High Polymers Section on problems relating to the ion-exchange and allied properties of synthetic resins. Considerable progress has been made in correlating the ion-exchange behaviour of polymers with their structure, and in the separation of pyridine and piperidine by the displacement–development technique on a cation exchange agent. Interesting results have been obtained from the study of the chemical reactivity of the chlorine atoms in polyvinyl chloride, particularly with ammonia and substituted ammonias. The discovery that, in the preparation of cold-setting resorcinol–formaldehyde adhesives, the technically pure resorcinol can be replaced by a crude resorcinol fraction from the low-temperature carbonization of coal provides a useful outlet for a virtual by-product.

Fuller details of these and other developments are given in the Director's own report. The Laboratory is now organised in four groups and an independent section, with an exploratory unit for investigations under the personal supervision of the Director. In the independent section, work carried out on polymers derived from bases other than hexamethylenediamine was being concluded; but the synthesis of long-chain compounds received considerable attention, including a continuous conversion of caproic acid to

* Department of Scientific and Industrial Research. Report of the Chemistry Research Board, with the Report of the Director of the Chemical Research Laboratory for the Year 1948. Pp. vi+82+2 plates. (London: H.M. Stationery Office, 1949.) 2*s.* net.

n-decane by a modified Kolbe reaction, and decarboxylation studies on succinic anhydride and on unsaturated acids. In the Corrosion of Metals Group additional work has been carried out on the high-speed and low-speed rotor-technique under immersed conditions, while further studies of the relation between the electrical conductance and the area of breakdown of paint coatings on metal immersed in sea-water have shown that small areas of paint breakdown have a greater relative effect than large areas. Corrosion tests of about sixty low-alloy steels, using the intermittent spray apparatus, have been completed, and quantitative tests confirm that the depth of colour of the corrosion product and its adhesion to its steel basis are closely associated with the corrosion characteristics of the metal. Other work has been concerned with organic corrosion inhibitors such as sodium phthalate and sodium benzoate, both under immersed conditions and in wrapping materials. A temporary protective has been formulated based on rubber latex with sodium benzoate as inhibitor. The influence of surface pre-treatment and the composition and structure of oxide films on mild steel have also received attention, while the Microbiology Section has studied the culture and morphology of sulphate-reducing bacteria and the inhibitory action of antibiotics and antiseptics towards such bacteria, and established that mild but not stainless steel is corroded in cultures of such bacteria, as well as that such bacteria are a supplementary factor in the internal corrosion of water mains, especially in clay soils.

The Inorganic Group has given further attention to the extraction of gallium and germanium from flue dust, to the lower valency states of gallium and to the preparation of pure vanadium pentoxide, as well as to general techniques for extraction, microanalysis and spectroscopic analysis. The Radiochemical Group continued to work on the same lines as in the previous year, including analytical methods for the determination of uranium, thorium and other elements in raw materials, and the extraction, concentration and separation of valuable metals from mineral products. In the Organic Group, the Purification and Measurement Section continued its work on the separation of tar constituents, including the purification of pyridine and its homologues, and discovered some new colour reactions for individual bases in this group. A method for the determination of carbazole by nitrosation was developed, and the investigation on the formation of azeotropes between the phenolic and basic constitutions of tar distillates in the creosote oil range has been completed. The report includes a description and diagram of an apparatus in which low-boiling organic compounds can be transferred from part to part by low-temperature distillation and without contact with the atmosphere. An ebulliometer has been designed for use with a thermistor which may be subjected to either the vapour or liquid temperature. Some earlier work on acenaphthylene derivatives has been extended with a Beckmann spectrophotometer, and a Hilger double-beam infra-red spectrometer has been brought into use for qualitative and quantitative analysis.

In the first Organic Intermediates Section, besides work on the hydrogenation of pyridine, the hydrogenation of diphenylene oxide has been examined, and the study of co-polymers containing acenaphthylene extended. The second Organic Intermediates Section has prepared further quantities of methylchlorosilanes and methylethoxysilanes and obtained some success in attempts to produce silicone grease. A coating resin containing 1·35 methyl groups per silicon atom was intermediate in performance between two commercial resins as a waterproof coating for high-stability carbon resistors. Besides the work on carbon isotopes already noted, the Section prepared specimens of refined stearic acid, methyl stearate and copper, ferrous, ferric, lead and lithium stearates for the National Physical Laboratory, and developed further an apparatus for the simultaneous preparation and sublimation of aluminium chloride. In the independent High Polymers and Plastics Section, besides the work on the reaction of polyvinyl chloride and on ion-exchange properties stressed by the Board, the investigation of the sorption of water-vapour by phenol-formaldehyde film continued, and considerable progress was made in investigating the interlaminar strength of reinforced plastics.

Appended to the Director's report are lists of publications and patents during the year by members of the Laboratory, a list of staff and members of committees, and of lectures and colloquia in which the Director or staff participated.

FORESTRY IN TRINIDAD AND TOBAGO

IN the annual report for 1947 (recently published) of the Forestry Department of Trinidad and Tobago*, the conservator, Mr. G. N. Sale, says that the year was in many respects a watershed between the war-time and post-war periods, just as it has proved in other Empire forestry departments. The War has not been without its good aspects in some directions, and forestry and forests are one of them. A marked change of attitude has been noticeable among the local people. They had to buy, though unwillingly, home-grown timber during the War, as there were no timber imports; they have now become accustomed to it, and local saw-mills are no longer a novelty. An example can be seen in the demand for mora timber, the difficulties of exploitation of which were often complained of in annual reports in the pre-war 'thirties and discussed in reviews in *Nature* of the period; the demand for this timber, says the report, showed no signs of decreasing, and new areas must be made accessible for the continued supply.

It is curious that it has taken a Second World War to bring about this recognition of the value of its own forests to a country, both to the administration and to the people it governs. The principles of a forest policy formulated in 1942, the main features of which have so often been repeated throughout the Colonial Empire and outside it, are reiterated in this report. It is to be hoped that this repetition nowadays may no longer go unheeded. The shortage of experienced staff is mentioned and can be appreciated as the stumbling block to progressive advance in almost every branch of work mentioned in the report.

Trinidad and Tobago are not alone here, for there is scarcely a Colony of which the forestry staff has been anything near approaching the required strength for the past thirty years. It is this shortsightedness on the part of the authorities concerned which has delayed almost until the twelfth hour so much urgent forestry administration and forest research and settlement.

* Colony of Trinidad and Tobago. Administrative Report of the Conservator of Forests for the Year 1947. Pp. 28. (Trinidad, 1949.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Groundnut Scheme in East Africa

MR. G. V. JACKS, in his review, published in *Nature* of December 24, 1949, of the first annual report of the Overseas Food Corporation, considers that, as disappointing as the beginning of the East African Groundnut Scheme has been, it could be considered a good one "had the scheme been laid down on a more moderate scale and carried out less extravagantly". May I be permitted to comment on this and to refer also to an editorial comment on the subject in *Nature* of December 31.

I would like to point out that when the Wakefield Mission was officially instructed before proceeding to Africa in June 1946, we were told, if the plan for the mechanized production of groundnuts presented to us was found to be feasible, to prepare a schedule for the production of not less than half a million tons of nuts annually by the end of five years. It was explained that the food position was extremely serious, particularly in regard to fats, vegetable oils and protein for cattle-feed; the fat shortage was regarded as a long-term problem. It should be remembered that at the time, even though supplies were available in North America to make up the loss of imports from Asia, dollars were short then as now, and 'Lend–Lease', which had carried us through the War, had been abruptly terminated. The present temporary alleviation through Marshall Aid was not in the picture; existing agricultural production could meet no more than half the current requirements of vegetable oil; the annual deficit to food-importing countries amounted to 2¾ million tons of oilseeds. Britain needed at least 1¼ million tons and her major remaining source of supply, Nigeria, could produce only about 300,000 tons. The killing of whales is still limited by international agreement.

In consequence, Parliament, recognizing the risks of quickly opening up large new areas of production as well as the urgent necessity of such development, approved the plan as described in the White Paper (Cmd. 7030). Subsequent criticism has arisen, not because of the inception of the plan, but as a result of the refusal to recast it over a longer period and on a less ambitious scale, when it was obvious that the prerequisites to success were not forthcoming. It is the cost of 'buying time' which has been fantastically wasteful.

A more realistic programme was not decided upon until the autumn of 1948; but by then the project was committed to vast expenditure in staff and equipment planned on the basis of the White Paper.

Mr. Jacks's review, and numerous comments and letters published in the Press, give the impression that, so far, most of the *major* errors and problems have been on the agricultural side. This has not been the case, for the first plantings in 1947–48 were negligible and the crops of 1948–49 were ruined by a serious drought which affected a large part of the African continent. The failure of the period 1947–49 has been due to faulty organisation, lack of the requisite engineering experience, bad management of men and the insistent call for speed which ran down an inexperienced administration. Despite these discouragements, the achievements of the men and women in Tanganyika have been prodigious.

Mr. Jacks suggests that the "correct procedure would have been to gain experience on a pilot-plant scale before launching out on to the perilous seas of large-scale production". This raises a fundamental question which is as vital to the economic position of Britain as it is to the economic development and political aspirations of Central Africa: namely, can the problems of large-scale development be determined and solved by relatively small-scale agronomic experiment?

The experience of the great Sudan Gezira Scheme (undertaken only after ten years experimentation) has proved that a relatively small-scale pilot experiment is more likely to mislead than to give results which can be widely extended. The real problems did not emerge until large-scale operations had been carried out; and the problems appeared to be so insuperable that abandonment of the project was seriously considered within a few years.

In my view, a new and more courageous type of research is required, if the necessary areas of new production are to be brought into use in our time. It should be noted that Dr. E. B. Worthington has spoken in terms of 500 square miles for the pilot community development projects which he proposed for Uganda three years ago. The size of pilot mechanized projects must be large enough to bring out the problems of the deployment and maintenance in undeveloped country of large fleets of heavy tractors and bush-clearing equipment; the development and dispersal of suitable agricultural machinery; the control of pests and diseases; the maintenance of fertility over land where, because of the absence of surface and subterranean water, it is impossible to keep livestock; and the ecological planning of anti-erosion measures. On the all-important human side it must be able to bring out the administrative capacity of man, as well as the domestic problems of suddenly introducing large numbers of European men and women into the African bush. It must not ignore the impact on the African people of large-scale production. A wealth of information exists at Kongwa, of enormous value to the development of tropical Africa; but the staff are too occupied with their task to collate it.

These and other matters of vital importance to the ultimate success of the Groundnut Scheme, and to other development which the economic position of Britain demands, cannot be determined unless there is first an inquiry, as has been suggested in *Nature*, "by a body the impartiality and authority of which would command general confidence; and, from the scientific point of view, this is what matters most". When one considers the issues at stake and the lack of confidence in the London management, which persists to an alarming degree in the men on the job, it is incredible that the Government would refuse an inquiry to ascertain the fundamental causes of the difficulties and failures of the scheme.

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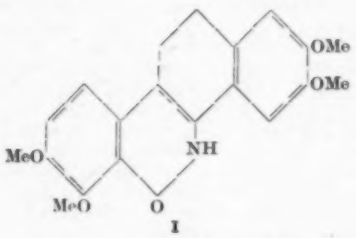
Jan. 25.

Synthesis of a Reference Compound derived from Sanguinarine and Chelerythrine

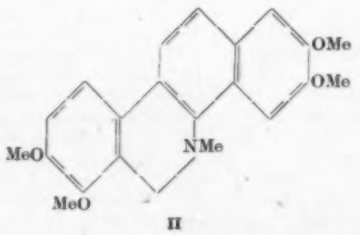
THE synthesis of 7 : 8 : 4′ : 5′-tetramethoxy-3 : 4-dihydro-1 : 2-benzphenanthridone (I) has already been reported[1]. By treatment with phosphoryl chloride, the change —CO—NH— → —CCl=N— was readily effected (found in the product, m.p. 176–178°; C, 65·2; H, 4·9; Cl, 9·9 per cent), and this chloro-compound, in boiling *p*-cymene solution, may be reduced by hydrogen in the presence of palladized carbon and simultaneously dehydrogenated to the related tetramethoxybenzphenanthridine (—CCl=N— → —CH=N— and loss of 2H by dehydrogenation, $—CH_2.CH_2—$ → —CH=CH—) (found in the product, m.p. 217–219°; C, 71·8, 72·1; H, 5·4, 5·3; N, 3·9 per cent).

The methosulphate of the latter base was changed by double decomposition into the methochloride, melting point 207–210° (found, C, 60·3; H, 6·2; Cl, 7·6 per cent, indicating $C_{22}H_{22}O_4NCl,2H_2O$), which is the tetramethoxy-analogue of sanguinarine chloride ($2CH_3O_2$) and chelerythrine chloride ($2MeO,CH_2O_2$).

On reduction with zinc in boiling aqueous hydrochloric acid, N-methyl-7 : 8 : 4′ : 5′-tetramethoxy-9 : 10-dihydro-1 : 2-benzphenanthridine (II) was produced.



I



II

This substance was obtained by Späth and Kuffner[2] from both dihydrochelerythrine and dihydrosanguinarine by hydrolysis of methylenedioxy groups followed by methylation.

We are deeply indebted to Dr. S. N. Sarkar for a specimen of this substance which he had prepared from dihydrosanguinarine.

The synthetic specimen crystallized in colourless prisms, melting point 182–184° (slight decomp.) (found, C, 72·6, 72·7; H, 6·5, 6·1; N, 3·9 per cent), and an intimate mixture with the specimen of natural origin (m.p. 183–185°) had melting point 183–185°.

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Nov. 9.

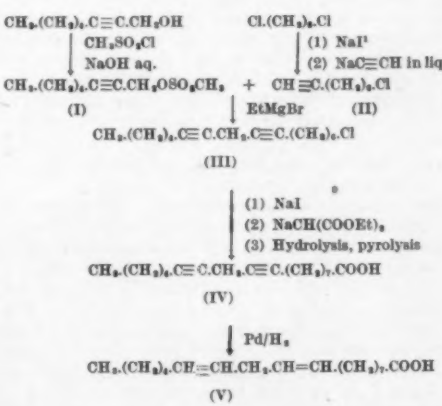
[1] Bailey and Robinson, *Nature*, **164**, 402 (1949).
[2] Späth and Kuffner, *Ber. deut. chem. Ges.*, **64**, 2034 (1931).

Synthesis of Linoleic Acid

THE problem of the synthesis of the naturally occurring unsaturated aliphatic acids (nearly all of which possess the *cis* configuration about the double bonds) has only recently come under investigation in any detail. This is mainly due to the difficulty of obtaining, by classical methods, pure *cis*-ethylenic compounds. The present rapid development of acetylene chemistry, coupled with the fact that catalytic partial hydrogenation of the triple bond results in the formation of an ethylenic compound of *cis* configuration, has removed this stumbling-block, and the exploitation of this technique is being widely studied.

The recent work of Ahmad, Bumpus and Strong[1] has established an elegant method of striking simplicity for producing long-chain monoacetylenic acids of type $CH_3.(CH_2)_x.C\equiv C.(CH_2)_y.COOH$ and thence, by catalytic partial hydrogenation, the corresponding *cis*-ethylenic acids. At the moment, this certainly constitutes the best procedure for synthesizing the natural mono-ethylenic fatty acids (for example, oleic acid, erucic acid, etc.).

A great many of the natural polyethylenic acids contain the grouping *cis* : *cis*—CH=CH.CH_2.CH=CH—. One of the most important of these is the widely distributed linoleic acid (octadeca-9 : 12-dienoic acid) (V), the characteristic acid constituent of the semi-drying oils[3]; the substance has added interest by virtue of its properties as an essential food factor[3]. The obvious intermediate for the synthesis of this compound is the corresponding β-diacetylenic acid (IV). A review of the scanty literature on β-diacetylenes reveals the inaccessibility of these compounds; only a few hydrocarbons of this series have been obtained, and these in poor yield owing to the reactivity of the methylene group situated between the triple bonds[4].



We have been successful in obtaining the required β-diacetylenic acid intermediate (IV) by the route indicated. An ethereal solution of the Grignard complex of the acetylenic chloride (II) was very slowly added to a boiling ethereal solution of an excess of the acetylenic methanesulphonate (I). This condensation procedure ensured that no excess Grignard reagent was present at any time to attack the central methylene group of the product (III). Conversion of the latter to the iodide, followed by the familiar malonic ester chain-lengthening process, yielded the

required β-diacetylenic acid (IV) as glistening plates, melting point 42–43°. Unfortunately, the high temperature needed for decarboxylation caused considerable resinification, and the yield of acid (IV) was correspondingly low; investigations to obviate this difficulty are now in progress.

A preliminary catalytic partial hydrogenation of the acid (IV) furnished a yellow oil which was identified as linoleic acid (V) by formation of its solid tetrabromide, melting point 112–113°, and by complete hydrogenation to stearic acid.

This work is being expanded and will be fully reported elsewhere. We are indebted to Sir Ian Heilbron and Prof. E. R. H. Jones for their interest in this work, which was carried out during the tenure of an I.C.I. Fellowship (R. A. R.) and a senior award of the Department of Scientific and Industrial Research (F. S.). Thanks are due to the Chemical Society for a research grant.

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Sept. 23.

[1] *J. Amer. Chem. Soc.*, **70**, 1699, 3391 (1948).
[2] Ralston, A. W., "Fatty Acids and their Derivatives" (Chapman and Hall, London, 1948).
[3] Rosenberg, H. R., "Chemistry and Physiology of the Vitamins", 531 (Interscience Publishers, New York, 1942).
[4] Grignard, V., and Lapayre, L., *C.R. Acad. Sci., Paris*, **192**, 250 (1931). Tchao Yin Lai, *Bull. Soc. Chim.*, **53**, 1537 (1933).

Preparation of Ethynylcarbinols from the Bisulphite Compounds of Aldehydes and Ketones

Whereas a variety of methods for the preparation of ethynylcarbinols from both saturated and unsaturated carbonyl compounds have been described[1], we have traced only one reference[2] in the literature to the preparation of diethynyl glycols, from dicarbonyl compounds and acetylene. While this work was in progress, Milas *et al.*[3] reported the preparation of the diethynyl glycols from diacetyl and acetonylacetone.

While aliphatic dialdehydes in particular are not easily accessible materials of low stability, their bisulphite compounds can frequently be obtained in a pure crystalline condition, and we find their purity readily determined by weighing the washed and dried precipitate formed by treatment with an excess of a standard solution of 2 : 4-dinitrophenylhydrazine sulphate.

We have now found that reasonable yields of ethynylcarbinols can be obtained from the bisulphite compounds of aldehydes and ketones by reaction with sodium acetylide in liquid ammonia. By this means the following pure ethynylcarbinols have been prepared in the yields stated: dimethylethynylcarbinol in 45 per cent yield, *n*-butylethynylcarbinol (32 per cent), phenylethynylcarbinol (45 per cent) and styrylethynylcarbinol (12 per cent), from the crystalline sodium bisulphite compounds of acetone, *n*-butaldehyde, benzaldehyde and cinnamaldehyde respectively. Styrylethynylcarbinol has previously been obtained in only 2 per cent yield[3] by reaction of cinnamaldehyde with sodium acetylide in liquid ammonia, and the method thus represents an improvement in this case.

Full details will be reported elsewhere; the application of the method to dicarbonyl compounds is under investigation.

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Sept. 22.

[1] Johnson, "The Chemistry of the Acetylenic Compounds" (Edward Arnold, London, 1946).
[2] Milas, Brown and Phillips, *J. Amer. Chem. Soc.*, **70**, 2862 (1948).
[3] Jones and McCombie, *J. Chem. Soc.*, 733 (1942).

Effect of Light on the Reaction between Periodates and α-Glycols

Since the original discovery by Malaprade of the cleavage of α-glycols by periodic acid and its salts, the reaction has been widely and increasingly used in the solution of structural problems connected with the carbohydrates. The course of the main Malaprade reaction with α-glycols and various compounds of similar type is well known, and the consumption of periodate is usually stoichiometric; but the literature contains many references to examples of so-called 'over-oxidation', or 'over-utilization', of periodate.

The cause of this may well vary from case to case; for example, I have shown[1] that whereas β-methyl glucoside and β-methyl cellobioside are oxidized stoichiometrically at $pH < 5$, very substantial over-oxidation occurs when the solutions are made alkaline. A factor of more general importance, which does not seem to have been noted hitherto, is the effect of light upon the course of the reaction.

Jackson and Hudson[2] and Davidson[3] observed that the amount of periodic acid or sodium *meta*periodate consumed in the oxidation of cellulose did not cease at the 'theoretical' value of one mole per C_6 unit, and figures as high as 1·22 for cotton and 1·86 for filter paper were reported. Davidson noted, too, the formation of considerable quantities of formic acid, formaldehyde and carbon dioxide, and it was evident that side reactions were occurring with both oxidants.

However, when I repeated Davidson's oxidation of cotton with sodium *meta*periodate, I found that the reaction virtually ceased when one mole of oxidant had been consumed (about twenty days at 20°), and even at the end of forty-one days the consumption was only 1·06 moles. A possible explanation of this discrepancy seemed to be that various chance circumstances had resulted in the almost complete shielding of the reaction mixture from light.

It has now been observed that with 1·6 moles of sodium *meta*periodate per C_6 unit, the oxidation of cotton at room temperature, and in the complete absence of light, virtually ceased when one mole of periodate had been consumed (about seventeen days in a particular experiment). When the reaction mixture was contained in a clear glass bottle accessible to bright daylight, oxidation was much more rapid and continued until all the available periodate had been consumed (1 mole after six days and 1·6 after eighteen days). With a much larger excess of periodate (3·7 moles $NaIO_4$ per C_6 unit) the consumption reached one mole in four days and 3·7 in twenty-five days when bright daylight was accessible to the reaction mixture.

The disappearance of periodate is followed in all cases by the appearance of free iodine; carbon dioxide can be detected, and the insoluble oxidized cotton has an appreciable carboxyl content not to be accounted for on the basis of the accepted mechanism of oxidation.

Similar results have been obtained for the oxidation of β-methyl glucoside and β-methyl cellobioside with sodium *meta*periodate. With a large excess of oxidant, the reaction does not terminate when the consumption of periodate and production of formic acid have reached the limits set by the classical Malaprade reaction, unless the experiment is carried out in complete darkness. In bright daylight, oxidation proceeds more rapidly and goes very much further.

There are very great variations in the rates of oxidation of different α-glycols (carbohydrates, glycosides, etc.) by periodate. It is probable that the disturbance of the normal reaction caused by irradiation is most pronounced when the 'dark reaction' is relatively slow, as it is in the oxidation of cellulose.

It is worthy of note that solutions of sodium *meta*periodate are themselves unstable when kept in bright daylight (for example, the concentration of a 0·03 *M* solution fell by about 10 per cent during fifteen days), and the odour of ozone first observed by Rammelsberg[4] is very pronounced. Solutions kept in the dark are both odourless and stable; illuminated reaction mixtures of sodium *meta*periodate with cotton or the glycosides do not smell of ozone.

Such evidence as is yet available points to the occurrence of far-reaching degradation during the photochemical reaction. The investigation of the subject is being continued in these laboratories.

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[1] *J. Text. Inst.*, **38**, T389 (1947).
[2] *J. Amer. Chem. Soc.*, **59**, 2049 (1937).
[3] *J. Text. Inst.*, **32**, T109 (1941).
[4] *Pogg. Ann.*, **134**, 534 (1868).

Isolation of a Saponin from the Heart-wood of the Mora Tree and of a Related Species, Morabukea

IN the course of a chemical examination of the wood of the mora tree, *Mora excelsa* (Benth.), from British Guiana and from Trinidad, we observed that the heart-wood contains an unusually high proportion of material soluble in water or alcohol, of which up to about one-half was found to consist of a saponin.

The saponin is most readily isolated by exhaustive extraction of the wood with hot alcohol, evaporation of the alcoholic liquor nearly to dryness, and trituration of the dark-coloured syrup with an excess of hot acetone. The colouring matter and other impurities pass into solution in the acetone, leaving a light-coloured amorphous solid, which is separated and purified by further treatment with acetone. The saponin is finally obtained as a very pale buff- or pink-coloured powder, the aqueous solution of which exhibits intense foaming properties. The saponin content of the heart-wood of a number of samples of mora from British Guiana was found to lie between 2·8 and 9·6 per cent, based on the dry weight of the wood. A saponin has also been found in the heart-wood of mora from Trinidad, and of the related species morabukea (*Mora gonggrijpii* (Kleinh.) Sandwith); but these woods have not been examined quantitatively. Although saponins are known to occur in small quantities in the wood of the boles of a few tree species[1], the wood of mora may prove to be a relatively rich source.

On hydrolysis with 6 per cent alcoholic hydrochloric acid for 30 min. at the boiling point, mora saponin yielded 21·4 per cent of a crude crystalline aglycone. Fractional crystallization of this product from ethyl alcohol resulted in the isolation, first, of a crystalline sapogenin of melting point 269–270° and $[\alpha]_D + 29{\cdot}5°$ ($c = 0{\cdot}83$ in chloroform) in a yield of 9·4 per cent of the dry weight of the original saponin (found: C, 76·67; H, 10·63 per cent). This sapogenin readily forms a monoacetate of melting point 255–257° (found: C, 76·91; H, 10·14 per cent). At least one other crystalline sapogenin is known to be present in the hydrolysis product of the original saponin. These substances are being further examined by Dr. D. H. R. Barton, to whom we are indebted for the suggestion that the principal sapogenin of melting point 269–270° is a new triterpenoid hydroxycarboxylic acid.

Hydrolysis of mora saponin with 5 per cent aqueous sulphuric acid at 95° for 4 hr. gave a mixture of sugars from which the aglycone was separated by filtration. After neutralization of the filtrate with barium carbonate and evaporation to dryness, the sugars were extracted with 90 per cent ethyl alcohol and isolated as a concentrated syrup. Examination of the syrup by partition chromatography on paper[2] revealed the presence of two sugars, which were probably glucose and xylose.

The research upon which this communication is based was carried out as part of the programme of the Forest Products Research Board on behalf of the Colonial Products Research Council. It is published by permission of the Department of Scientific and Industrial Research and the Colonial Products Research Council.

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[1] Wise, L. E., *et al.*, "Wood Chemistry", 436 (Reinhold, New York, 1944).
[2] Partridge, S. M., *Nature*, **158**, 270 (1946).

Preparation of Carbonate-free Sodium Hydroxide

WE have been studying the carbonate – hydroxide ion exchange on the strong base resin 'Amberlite IRA-400' (manufactured by Rohm and Haas Company and supplied by Messrs. Charles Lennig and Co., Ltd., 1–11 John Adam Street, London, W.C.2). It was expected that the bivalent ion would be preferentially held by the resin, and this is so. The following figures show the results of bringing the resin in the carbonate form into equilibrium with various sodium hydroxide solutions.

$(CO_3/OH)_R$	$(CO_3/OH)_S$	Total conc.
1·37	0·062	0·0976
2·16	0·095	0·04912
3·82	0·167	0·0196

The first two columns give the carbonate – hydroxide ratios at equilibrium, in the resin and in the corresponding solution, measured in equivalents, and the third the total concentration of the solution in gram-equivalents per litre.

An efficient chromatographic separation of carbonate and hydroxide is clearly possible, and offers a very simple method of preparing the carbonate-free alkali continually needed for volumetric work and in the preparation of buffer solutions. Rather more than the required amount of alkali is made up, without special precautions, from washed sticks, and a column of the resin, which may be initially in the form of its chloride, is prepared in the usual way. The capacity of the air-dry resin is 1·4 milli-equivalents per gram, and a 50-ml. tube two-thirds full of the resin would be suitable for preparing 1 litre of 0·1 *N* sodium hydroxide. The alkali is passed through the resin until the effluent is chloride-free (if necessary), and the tube is then transferred to the neck of the stock bottle. When the rest of the alkali has passed through, the resin column is replaced by a sodalime guard tube, and the carbonate-free sodium hydroxide is ready for standardization.

The direct replacement of carbonate in the exhausted resin by hydroxide is difficult, but the column can be easily regenerated by the passage of hydrochloric acid, which destroys the carbonate, and the subsequent replacement, as described, of the chloride by hydroxide.

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Sept. 26.

Recrystallization of Regenerated Cellulose upon Mercerization

In a recent paper[1], it was shown by application of a quantitative X-ray[2] method[2] that viscose rayon fibres, upon boiling with 2·5 *N* sulphuric acid, exhibit a distinct increase in crystallinity from 40 per cent initially to nearly 50 per cent, which is terminated within half an hour. The decrease of water sorption after the treatment was in line with this result.

It has now been found that a similar recrystallization can be effected by 'mercerization'. Four different rayon fibres were soaked in 18 per cent caustic soda solution at room temperature for 10 min., freed from lye by pressing between filter paper, and put into a large quantity of boiling water to remove the residual caustic soda. After rinsing with dilute acetic acid and then water, the fibres were dried in the air.

The loss in weight owing to the previous operations amounted to 3–6 per cent. Examination with X-rays (method of ref. 2) of four different rayon samples thus treated yielded a percentage crystallinity varying between 50 and 55 per cent (taking into account the small loss in weight), and thus an even somewhat larger increase than that obtained by acid hydrolysis.

The recrystallization upon acid hydrolysis has tentatively been explained as follows. Cutting of part of the chains in the amorphous regions of the irregular partly crystalline network structure in the cellulose gel may remove part of the entanglements, or restore some of the inhibited segmental freedom of movement and rotation which prevent further growth of the crystalline regions. It remains to be investigated whether the result of the mercerization experiments can or cannot be explained in a similar way.

Experiments repeated in an oxygen-free atmosphere and thus excluding chemical degradation will be required in this connexion. Further work along this and other lines is in progress.

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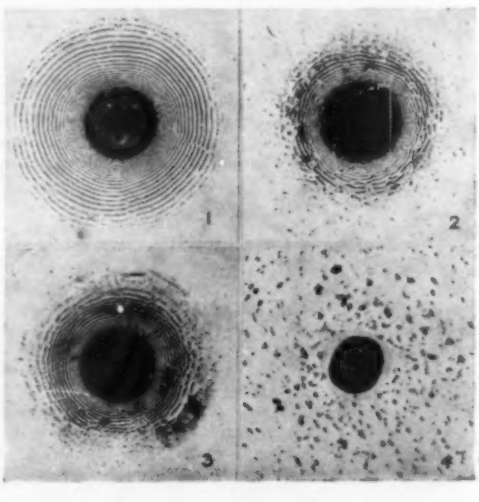
Sept. 19.

[1] Hermans, P. H., and Weidinger, A., *J. Polymer Sci.*, **4**, 317 (1949).
[2] Hermans, P. H., and Weidinger, A., *J. App. Phys.*, **19**, 491 (1948); *J. Polymer Sci.*, **4**, 135 (1949).

Electric Potential of Solutions as a Cause of the Formation of Liesegang Rings

Following our experiments in relation to the influence of electric current on the formation of Liesegang rings, it has been found that silver nitrate (diluted) drops on chromogelatine cause a potential difference of nearly 80 millivolts. The silver nitrate has a positive, and the chromogelatine a negative, potential. This potential difference lasts only so long as silver dichromate is being formed. At first it decreases very quickly, and at the same time with the quick appearance of the rings; later, the rate of decrease becomes slower, parallel with the slower formation of the rings. If the silver nitrate–chromogelatine pair is short-circuited (by short-circuiting the electrodes), then a change is observed in the appearance of the Liesegang rings; normal rings are shown in Fig. 1 and modified rings in Figs. 2 and 3.

The short-circuit causes a much more rapid decrease of the potential difference, although it still lasts more than fifty hours. Therefore, we have tried



to get a better short-circuit by using instead of a glass plate a silver plate, so that there can no longer be any difference of potential between the chromogelatine and the drops of silver nitrate. In these circumstances, the formation of Liesegang rings has not been observed; the formation of the periodic precipitate ceases, and instead of it a homogeneous diffuse precipitate appears (Fig. 4). This shows that the formation of a periodic precipitate in an isotropic colloidal medium is very similar to the phenomena of liquid-contact potentials. On eliminating this potential, periodic precipitation does not occur.

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Sept. 9.

Dipole Moments of some *Ortho*-Substituted Anilines

WE have measured the dipole moments of aniline, N-methyl aniline, N,N-dimethyl aniline, and corresponding toluidines and xylidines. As is seen from the accompanying table, alkylation affects the dipole moments of aniline and *p*-toluidine to a small extent, the difference in dipole moment between the primary and the tertiary amines being about 0·05 Debye. In the case of *ortho*-substituted amines, however, the substitution of two methyl groups at the nitrogen atom lowers the dipole moment by about 0·7 Debye. The dipole moments of these tertiary aniline homologues have almost the same value as that of aliphatic tertiary amines, namely, 0·8 Debye[1]. This result is in good agreement with the result obtained by Thomson[2] from measurements of molecular refractivities. He calculated that the atomic refractivity of nitrogen in dimethyl 2,6-xylidine approaches very closely the value for nitrogen in a tertiary aliphatic amine. Furthermore, Remington[3] has found from ultra-violet absorption spectra that the resonance is inhibited in *ortho*-substituted derivatives of dimethyl aniline.

	μ	Δ
Aniline	1·59	0·04
Dimethyl aniline	1·55	
p-Toluidine	1·35	0·05
Dimethyl *p*-toluidine	1·30	
o-Toluidine	1·60	0·7
Dimethyl *o*-toluidine	0·9	
2,4-Xylidine	1·34	0·6
Dimethyl 2,4-xylidine	0·7	
2,6-Xylidine	1·65	0·7
Dimethyl 2,6-xylidine	1·0	

The investigation of the dipole moments of the monomethyl aniline derivatives, which is being continued in this laboratory, does not show any pronounced difference between the *ortho*-substituted secondary amines and the corresponding non-substituted one. Full details of the measurements will be published elsewhere.

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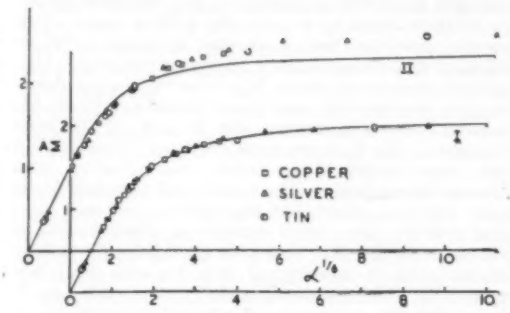
Sept. 20.

[1] Ghosh, P. N., and Chatterjee, T. P., *Phys. Rev.*, **37**, 427 (1931).
[2] Thomson, G., *J. Chem. Soc.*, 408 (1944).
[3] Remington, W. R., *J. Amer. Chem. Soc.*, **67**, 1838 (1945).

Anomalous Skin Effect in Metals

AT sufficiently low temperatures and high frequencies, the mean free path of the electrons in a good conductor becomes greater than the classically predicted skin depth, and the classical skin-effect equations break down. Pippard[1] has studied the effect at liquid helium and liquid hydrogen temperatures, and Reuter and Sondheimer[2] have given the quantitative theory of the effect, and have interpreted Pippard's results. They found that for tin, mercury and aluminium, the experimental results implied reasonable values for the ratio σ/l of conductivity to electronic mean free path, but that for copper, silver and gold they implied values lower than the expected values by a factor of 5 or more. It was suggested that these low values were due to surface conditions differing from those in the bulk metal. In order to study this suggestion and to make a more detailed comparison with the theory than was possible on the basis of Pippard's measurements, a new investigation has been carried out in which attention has been paid to surface conditions, and the whole temperature range from 2° K. to 90° K. has been covered.

An electrically heated cryostat was built, capable when immersed in a bath of liquid helium or liquid hydrogen of maintaining any temperature between 2° K. and 90° K. for an indefinite period. The radio-frequency conductivity of the specimens was measured at about 1,200 Mc./s. by the method used by Pippard, and simultaneous measurements of the D.C. conductivity were made on similar specimens.



I, Experimental points fitted to $p = 0$ curve. II, Attempt to fit to $p = 1$ curve. Full lines theoretical

Measurements have so far been made on tin, cast in silica capillaries, and copper and silver, electrolytically polished. For all specimens, the results indicate that reflexion of electrons at the surface is completely diffuse, at all temperatures. The accompanying graphs show typical results on three specimens, scaled (I) to fit the theoretical (Reuter and Sondheimer) curve for completely diffuse reflexion ($p = 0$), and (II) in an attempt to fit the curve for specular reflexion ($p = 1$). It might have been expected that the 'reflexion coefficient' p would rise as the temperature was lowered and thermal disturbances at the surface became smaller: that this is not observed presumably indicates permanent surface irregularities of the order of magnitude of the electronic wave-length, that is, a few angstroms. The Reuter and Sondheimer curves relate two variables $A\Sigma$ and α; here $A\Sigma$ is proportional to the observed Q of the specimen, the scaling factor depending on

the geometry of the resonator and the constant of the metal, and $\alpha = 3l^2/2\delta^3$, where l is the mean free path and δ the classical skin depth. Hence $\alpha^{1/3} \propto \sigma$, the D.C. conductivity; the constant of proportionality differs from metal to metal, and from it may be found the 'free-electron' values of σ/l and also of n_e/n_a, the effective number of conduction electrons per atom. The values thus deduced from the experiments on tin, copper and silver are given in the accompanying table (specimens Sn, Cu, Ag); the probable errors of these figures are about $\pm$ 5 per cent. Also given, for comparison, are the results deduced from Pippard's measurements (Sn (P), etc.), which have rather larger probable errors, and from measurements on two other specimens treated as described below (Cu A, Cu B).

Specimen	σ/l (ohm^{-1} cm.$^{-2}$ × 10^{15})	n_e/n_a
Sn	9·5	1·1
Sn (P)	8·0	0·87
Ag	9·0	0·66
Ag (P)	1·7	0·052
Cu	17·0	1·17
Cu (P)	2·8	0·1
Cu A	2·9	0·1
Cu B	15·0	0·97

It will be seen that for tin the present results are of the same order as Pippard's result Sn (P), but that for copper and silver the present figures are much higher and much closer to the expected figures. Whereas Pippard's specimens were annealed but otherwise left unaltered after drawing down to the required diameter, specimens Cu and Ag were electrolytically polished to remove the surface layer. Two mechanisms have been suggested to account for the effect of the surface layer: (i) roughness, and (ii) increased resistivity owing to cold-work during drawing, not removed by subsequent annealing. To decide between these, specimens Cu A and Cu B were measured. Cu A, a specimen previously measured in the electro-polished condition, was treated with 'Brasso' metal polish. The surface still appeared to be very highly polished, but the effect on σ/l and n_e/n_a was drastic; they were reduced to about the same values as for Cu (P). Specimen Cu B, also previously electropolished, was dipped in nitric acid for a few moments, which produced a dull mat surface, showing under the microscope considerable roughness of the required order of magnitude, that is, a few thousand angstroms. It will be seen, however, that the effect on σ/l and n_e/n_a is small. It is therefore concluded that the predominant cause of high surface losses is a high-resistance surface layer. By analysing the form of the curve for Cu A, it was possible to deduce on this assumption that the surface layer extended for more than 2,000 angstroms below the surface, and had a residual resistivity about ten times that of the bulk metal.

Experiments are in progress on gold and the alkali metals, and also on metals other than Group I metals.

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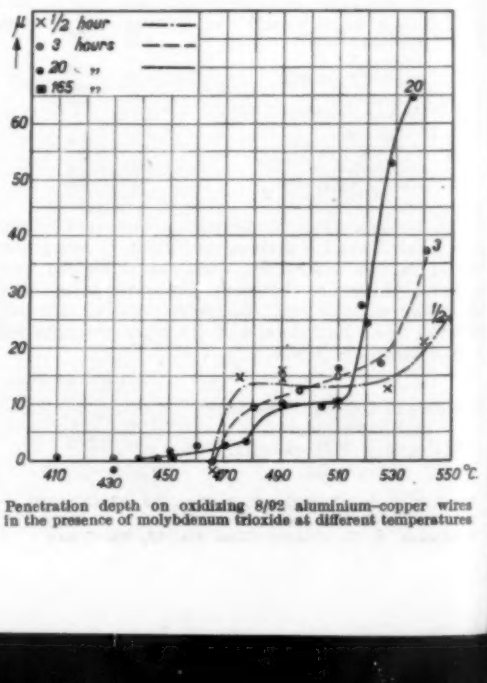
Nov. 10.

[1] Pippard, A. B., *Proc. Roy. Soc.*, A, **191**, 385 (1947).
[2] Reuter, G. E. H., and Sondheimer, E. H., *Proc. Roy. Soc.*, A, **195**, 336 (1948).

Rapid Oxidation of Metals and Alloys in the Presence of Molybdenum Trioxide

In studying heat-resistant iron-base and copper-base alloys at 750° C., we observed a pronounced increase of the rate of oxidation, when the atmosphere was contaminated by molybdenum trioxide vapour. In the meantime, this effect has been discovered independently by Leslie and Fontana[1], who observed above about 800° C. a rapid oxidation of steels with a high content of molybdenum. These authors ascribed the abnormal oxidation to a catalytic action of molybdenum trioxide, the thermal dissociation into molybdenum dioxide and nascent oxygen being the important factors in their opinion.

In connexion with the low melting point of molybdenum trioxide (790° C.) we wished to settle the question whether a liquid oxide phase hampers the development of a protective oxide film, thus causing the rapid oxidation. To this end we studied the temperature-dependence of the influence of molybdenum trioxide on the oxidation of different metals and alloys. Here we wish to restrict ourselves to a description of the influence of the trioxide on the oxidation of aluminium–copper, copper, silver and aluminium–silver. These materials are especially interesting because molybdenum trioxide markedly influences their rate of oxidation at such low temperatures (below 500° C.) that the thermal decomposition of molybdenum trioxide can be disregarded. At these temperatures even the vapour pressure of molybdenum trioxide is very small (at 500° C., $\sim 10^{-4}$ mm. mercury). Therefore the oxidation was carried out in such a way that the metallic specimens were at the same time in contact with air and with the trioxide powder. Weighing experiments, micrographic analysis and tensile tests of oxidized wires gave reasonable agreement as to the effective depth of penetration d, caused by the action of molybdenum trioxide. The values of d determined for 8/92 aluminium–copper in the accompanying graph refer to tensile tests and are defined as $d = r_0(1 - \sqrt{K_M/K_A})$, where r_0 is the original radius of the wire, while K_M and K_A are the forces required to rupture the wires



Penetration depth on oxidizing 8/92 aluminium–copper wires in the presence of molybdenum trioxide at different temperatures

heated for the same time and temperature with molybdenum trioxide and in pure air respectively.

Above 470°, molybdenum trioxide influences the oxidation of aluminium–copper (which is negligible in pure air up to 750° C.), while a subsequent sharp increase is seen, as for *OFHC* copper, near 530° C. In agreement with this, liquid was found in mixtures prepared from molybdenum dioxide and trioxide and cuprous oxide above 470° C., while the trioxide and cuprous oxide form a eutectic at 530° C.

For silver and its alloys, molybdenum trioxide was found to influence the rate of oxidation at temperatures well below 400° C., while the lowest eutectic for mixtures of molybdenum dioxide and trioxide and silver molybdate was found near 490° C. However, the case of silver and its alloys is more complicated. At atmospheric pressure pure silver can only be oxidized above 180° C. if silver oxide is stabilized by other oxides[2], for example, by the formation of silver molybdates (we found that silver molybdate melts without decomposition in air at 570° C.). Hence molybdenum trioxide influences the rate of oxidation of silver alloys even when no liquid is formed.

The surface conditions of specimens oxidized in the presence of the liquid oxide mixtures were examined. In the case of aluminium–copper, a layer of pure copper appears on the former surface. A corresponding phenomenon was observed by Hallowes and Voce[3] in corrosion experiments with steam contaminated with sulphur dioxide. In the case of 4/96 aluminium–silver, layers of pure silver alternate with oxide layers. The liquid forms first at some weak spots of the protective aluminium oxide layer present on these alloys, which leads for a fixed temperature to a rate of oxidation which increases with time.

It might be supposed[4] that in the presence of liquid the attack will be mainly intergranular. In fact, there was always a preference for grain boundaries, but a separation of grains along high-energy boundaries only—not twin boundaries—was found in the case of silver.

In connexion with the influence of molybdenum trioxide on the oxidation of stainless steels already referred to, it may be mentioned that iron- and molybdenum-oxides form a eutectic near 730° C. This seems to agree with our view that the occurrence of a liquid oxide phase is the determining factor, not the dissociation of molybdenum trioxide.

A full account of the experiments is to appear in *Philips Research Reports*.

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N.V. Philips' Gloeilampenfabrieken,
Eindhoven. Sept. 15.

[1] Leslie, W. C., and Fontana, M. G., *Trans. Amer. Soc. Metals*, **41**, 1213 (1949).
[2] See Schenk, R., *Z. anorg. allg. Chem.*, **249**, 88 (1942).
[3] Hallowes, A. P. C., and Voce, E., *Metallurgia*, **34**, 119 (1946).
[4] Smith, C. S., Metals Technology Technical Publication 2387 (June 1948).

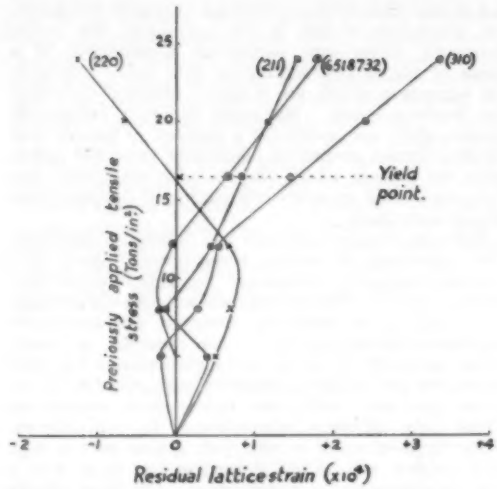
Residual Lattice Strains in Mild Steel

While it is established from the work of Wood[1] and others that, after plastic deformation of a polycrystalline metal aggregate, residual lattice strains are left in the individual grains at normal temperature, considerable speculation still exists as to the origin and distribution of these strains. It is customary to apply X-ray diffraction methods to this problem, and as has often been pointed out, owing to the selective properties of the X-ray technique, the strain measured, using any particular X-radiation, is a mean of the lattice strains in only those grains in the aggregate which are suitably oriented to reflect the incident beam. By using different radiations, Greenough[2,3] has shown for a number of metals that residual lattice strains in plastically extended aggregates are present which vary in both magnitude and sign, depending upon the orientation of the particular grains examined.

Recently, Greenough[3] has put forward a quantitative hypothesis to explain these results, based on a concept originally introduced by Heyn[4] to explain creep recovery. The explanation involves the assumption that, in a randomly oriented polycrystalline aggregate deforming under, for example, a tensile stress, some grains, in which the glide planes and glide directions are suitably oriented with respect to the stress direction, will yield before their neighbours which have different orientations. In consequence, if the applied stress is removed, grains with a high yield-tension will be left in tension and those with a low yield-tension in compression. If these effects occur on a scale which is alone sufficient to explain the residual lattice strains observed, it should be possible by X-ray methods to detect disorientation in given families of grains in a polycrystalline aggregate at differing values of applied stress.

Experiments have been carried out in this Laboratory to test this point on mild steel. Flat bars machined from a sample of a 0·14 per cent carbon steel (B.S. Specification 2S14) were first annealed and electrolytically polished to produce a high degree of grain perfection as shown by sharpness of the X-ray reflexion spots, and then subjected to a series of homogeneous, uniaxial tensile loads in an Amsler machine. After each load, the bar was removed and examined in a precision X-ray back-reflexion camera, with the incident beam at both normal and an oblique angle of incidence to the surface, before being subjected to the next load. By using cobalt, chromium, molybdenum and iron radiations, reflexions were obtained from six families of ferrite grains in which the 211 (Cr $K\alpha$), 220 (Fe $K\alpha$), 222 (Co $K\beta$), 310 (Co $K\alpha$, Fe $K\beta$), 651 or 732 (Mo $K\alpha$) and the 800 (Mo $K\alpha$) reflecting normals were approximately perpendicular to the surface of the bar and the stress direction for normal incidence, or made known angles for oblique incidence of the X-ray beam. In the neighbourhood of the yield-point for the material, the increments of stress between each successive load were narrowed to 0·5 ton/in.^{2} to fix the yield-point within small limits. It was found that all the X-ray patterns from the different radiations for both normal and oblique incidence exhibited uniform breakdown of the grains for the *same* value of previously applied stress (16·5 ton/in.^{2}). After loading to 16·5 ton/in.^{2}, one of the bars was electrolytically polished to reduce its thickness by 0·008 in. and then re-examined in the X-ray camera. All the families of grains examined previously still exhibited the onset of disorientation in the grains, showing the effect was not confined to the surface layers.

In addition to taking stationary photographs for the test just described, a series of patterns was also obtained for normal incidence of the X-ray beam, in which the specimen was oscillated through $\pm 2\frac{1}{2}°$ to enable residual lattice strains to be determined. Particular care was taken in the experimental technique to reduce sources of error to a minimum.



Typical results obtained are shown in the accompanying figure, the probable error in lattice-strain varying from about $\pm 1 \times 10^{-4}$ to $\pm 3 \times 10^{-4}$, depending on the planes examined. For present purposes, the point of interest which emerges is that the family of grains in which the (220) reflecting normals are approximately perpendicular to the direction of previously applied stress not only exhibits negative residual lattice strains after breakdown of the grains has occurred (as shown by the stationary photographs), in agreement with previously published results[2], but also positive strains for lower values of stress. It will be observed that all the spacings measured showed evidence of small but detectable residual strains for previously applied stresses well below the nominal yield-point. Similar effects have been observed for other stress versus lattice strain experiments which are in progress, and will be discussed in detail elsewhere.

It is difficult to explain these effects solely on the basis of a system of Heyn stresses arising from the interaction between any grain and its neighbours. Further work is being carried out in an attempt to sort out the relative importance of various influences which may account for these results.

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Sept. 22.

[1] For example, Wood, W. A., *Proc. Roy. Soc.*, A, **192**, 218 (1948).
[2] Greenough, G. B., *Nature*, **160**, 258 (1947).
[3] Greenough, G. B., *Proc. Roy. Soc.*, A, **197**, 556 (1949).
[4] Heyn, E., *J. Inst. Met.*, **12**, 3 (1914).

The Fundamental Relation between the Magnetic Moment and the Structure of Rotating Celestial Bodies

Blackett's suggestive formula[1] connecting the magnetic moment of a rotating celestial body P with its angular momentum U,

$$P = \beta \frac{G^{1/2}}{2c} U, \qquad (1)$$

where G represents the constant of gravitation, c the velocity of light and β a dimensionless quantity of order unity, has rightly aroused a great deal of criticism when it was considered to imply that every moving particle bears a virtual negative electric charge proportional to its mass.

This note is to show that we can arrive at formula (1) by very simple reasoning, by assuming that these celestial globes possess a nucleus of degenerate matter from which free electrons migrate into the outer shell more easily than the positive ions.

Let r be the radius of the core. It has acquired in the steady state a negatively charged envelope and a positively charged superficial layer, each of thickness Δ. Then the magnetic moment produced by the rotation of this charge is

$$P = \frac{16}{3} \pi \frac{\varepsilon r^3 \Delta^2 \omega}{c}, \qquad (2)$$

where ε is the density of the volume charge.

The force with which an electron is attracted by the positive sphere is

$$k = 4\pi \Delta \varepsilon e, \qquad (3)$$

and the energy required to lift the electron to the height Δ above the positive sphere is

$$k\Delta = 4\pi \Delta^2 \varepsilon e. \qquad (4)$$

Assuming this energy to be proportional to the mean kinetic energy of the particles constituting the body or proportional to the absolute temperature T_r at a distance r from the centre, we obtain:

$$4\pi \Delta^2 \varepsilon e = \varkappa R T_r, \qquad (5)$$

where R is the gas constant and $\varkappa$ is a dimensionless quantity.

We have arrived now at the relation

$$P = \frac{4}{3} \varkappa R \frac{r^3 T_r}{ec}, \qquad (6)$$

which, if I am right, is the fundamental relation for which we are looking.

The transformation of (6) into (1) is very easy. When r is a substantial fraction of r_0, the radius of the celestial body, T_r is equal to T_m, the mean temperature of this body. But[3]

$$T_m = \alpha \frac{G\mu}{R} \frac{M}{r_0} = \alpha \frac{G\mu}{R} \cdot \frac{4}{3} \pi \rho_m r_0^2, \qquad (7)$$

where M denotes the mass of the celestial body, ρ_m its mean density, μ the average mass of one molecule, and α is a dimensionless quantity of order unity depending on the internal structure of the body.

Let γ represent the ratio of r to r_0; then

$$P = \frac{10}{3} \frac{\alpha \varkappa}{\gamma^3} \frac{G\mu}{ec} U. \qquad (8)$$

With the substitution of the dimensionless quantities

$$\tau = \frac{\mu}{e} G^{1/2} \quad \text{and} \quad \beta = \frac{20}{3} \frac{\alpha \varkappa \tau}{\gamma^3}, \qquad (9) \text{ and } (10)$$

we obtain (1).

The theory can be applied equally well to two bodies which are so different as a planet and a star. Facts prove the existence of the nucleus of the earth, whereas theories of the internal constitution of the stars tend towards the acceptance of stellar cores.

Moreover, from (7) it would follow that the mean temperatures of the earth and the sun are in the ratio

$$\rho_\sigma r_\sigma^2 / \rho_s r_s^2, \qquad (11)$$

other variables supposed equal, where r_e and ρ_e are the radius and average density of the earth, r_s and ρ_s the radius and average density of the sun.

As ρ_e/ρ_s is roughly 4 and r_e/r_s is roughly 1/100, we obtain, when a mean temperature of 6,000° for the earth is assumed, a mean temperature of 15,000,000° for the sun, which is of the right order of magnitude.

The theory involves that the magnetic field experienced at the surface of a globe may be greatly modified by the characteristics of its shell, as is the case with the earth. It is a modification of Angenheister's theory, which was based on the surplus negative charge attached to the surface of the earth, but without its apparent quantitative defects. A quantitative verification of the present hypothesis depends on the calculation of the factor $\varkappa$, which may find its early solution in theories of thermal diffusion already developed.

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Aug. 20.

[1] *Nature*, **159**, 658 (1947).
[2] For example, Eddington, "The Internal Constitution of the Stars".

Sudden Commencements in Geomagnetism: their Dependence on Local Time and Geomagnetic Longitude

In 1948, H. W. Newton[1] found that the diurnal frequency of occurrence of 'sudden commencements' associated with geomagnetic disturbances at Greenwich over the period 1879–1944 had a broad minimum around 8 hr., and suggested that the effect was likely to be a local one. The available data from certain other observatories appeared to support this view.

There are three main types of sudden commencements. The first, or ordinary one, is characterized by an increase in the horizontal force, H, within a few minutes, following a quiet period. In the second, the increase in H is preceded by a smaller preliminary movement in the opposite direction. The third, and less frequent, type is called the 'inverted sudden commencement', because the movement is characterized by a decrease in H.

The interesting and important fact that a world-wide phenomenon should exhibit a local-time effect suggested the necessity of analysing the data from other magnetic observatories. We give here a preliminary table and account of the results. The traces for observatories 1–4 were kindly lent by the Director of the United States Coast and Geodetic Survey for the purpose of our analysis, which was confined to the horizontal force data.

Observatory	Geomagnetic Latitude	Geomagnetic Longitude	Period
1. Cheltenham	50·1° N.	350·5°	1922–46
2. Tucson	40·4 N.	312·2	1910–46
3. San Juan	29·9 N.	3·2	1926–46
4. Honolulu	21·1 N.	266·5	1902–46
5. Huancayo	0·6 S.	353·8	1922–46
6. Watheroo	41·8 S.	185·6	1919–46

We find that the diurnal variation of frequency at stations 1, 2, 6 in middle latitudes shows the 8-hr. minimum found by Newton at Greenwich; but at the three stations 3, 4, 5 in low latitudes the 8-hr. minimum is apparent only for sudden commencements which are followed by large or moderate disturbances. If all the sudden commencements at these low-latitude stations are analysed, the frequency curve appears to exhibit no special feature. This is illustrated in Fig. 1, which shows the frequency curves obtained by combining the data at all seven stations, including Greenwich (Curve I), at the four middle latitude stations (Curve II), and at the three low-latitude stations (Curve III).

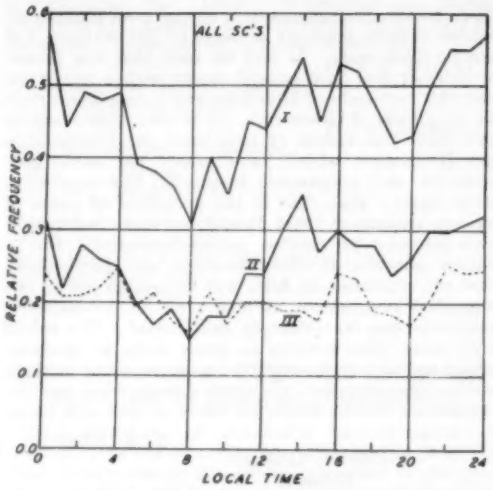

Fig. 1. Mean hourly frequency of sudden commencements. I, Combined data at all seven stations; II, combined data at Stations 1, 2, 6 and Greenwich only; III, combined data at Stations 3, 4 and 5 only

We have also formed the opinion that the frequency of occurrence of the second kind of sudden commencement depends on universal time and that, in the main, this type is more frequent in the hours following 12 hr. G.M.T. This suggests a possible dependence on geomagnetic longitude, and in Fig. 2 we have plotted the ratio of the number of second-

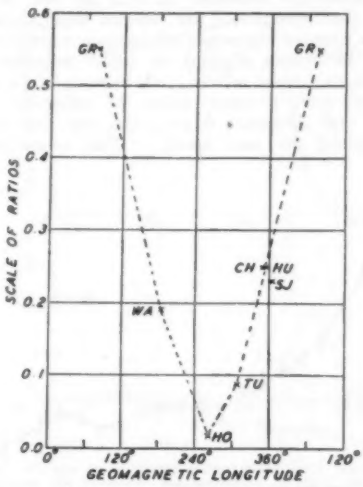

Fig. 2. Variation with geomagnetic longitude of the ratio of the number of second-type sudden commencements to all sudden commencements

type sudden commencements to the total number of sudden commencements at each of the stations 1–6 and at Greenwich. It will be seen that the points lie more or less on a smooth curve with a minimum near the longitude of Honolulu and a maximum near the longitude of Greenwich. It is also interesting to note that the values of this ratio for Cheltenham and Huancayo, which have nearly the same geomagnetic and geographic longitude, are approximately equal; also, that in the period of 46 years of records examined from Honolulu, there were only nine second-type sudden commencements. But a similar analysis at other stations, and particularly over the continent of Asia, will be needed before the suggested dependence of this type on geomagnetic longitude can be definitely established. We would urge other observatories to make such an analysis, which would help towards the understanding of these sudden movements in the earth's magnetism and the extraneous factors which are likely to influence them.

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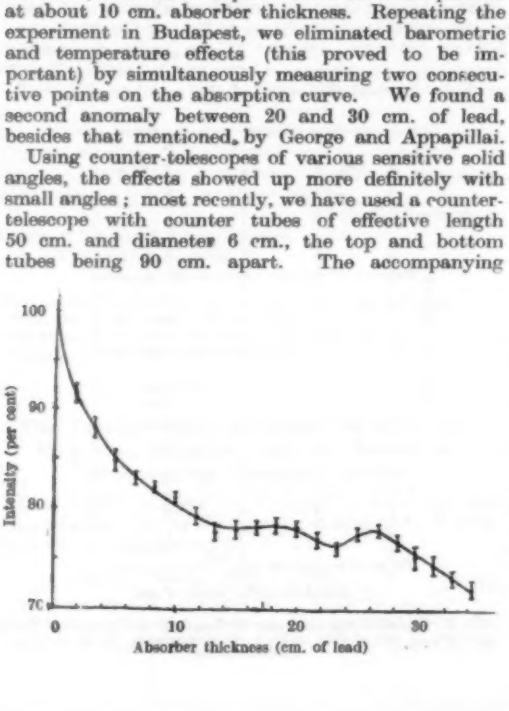
Sept. 10.

[1] *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 159 (1948).

Anomalies of the Absorption Curve of Cosmic Rays in Lead

Investigating the absorption of the vertical component of cosmic radiation in lead by means of a Geiger–Müller counter-telescope, George and Appapillai[1] found in 1945 at sea-level (London and Colombo) that the absorption curve showed a plateau at about 10 cm. absorber thickness. Repeating the experiment in Budapest, we eliminated barometric and temperature effects (this proved to be important) by simultaneously measuring two consecutive points on the absorption curve. We found a second anomaly between 20 and 30 cm. of lead, besides that mentioned by George and Appapillai.

Using counter-telescopes of various sensitive solid angles, the effects showed up more definitely with small angles; most recently, we have used a counter-telescope with counter tubes of effective length 50 cm. and diameter 6 cm., the top and bottom tubes being 90 cm. apart. The accompanying graph shows the results obtained at barometric pressures between 750 and 760 mm. mercury. At the absorber thickness of 18·2 cm. lead, within the plateau of George and Appapillai, we observed a maximum smaller than the standard deviation; at 26·6 cm., however, the second anomaly consists of a maximum amounting to 2·5 times the standard deviation; thus we consider it to be real. At barometric pressures of more than 760 mm. mercury, this maximum shifts to smaller absorber thicknesses; at pressures lower than 750 mm. mercury, it is to be found at larger absorbing layers. Further investigations into this effect are being carried out.



It should be mentioned that Clay and co-workers[2–4] demonstrated the existence of a second and third maximum—besides that at 1·6 mm. lead—on the ionization curve at about 16 and 25 cm. lead, as well as[2–5] a second maximum between 16 and 21 cm. lead on the shower curve, both curves being plotted against the absorber thickness.

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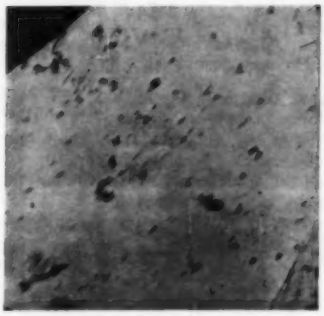
Budapest.
Sept. 15.

[1] George, E. P., and Appapillai, V., *Nature*, **155**, 726 (1945).
[2] Clay, J., *Physica*, **3**, 332 (1936).
[3] Clay, J., Gemert and Wiersma, *Physica*, **3**, 627 (1937).
[4] Clay, J., Venema and Jonker, *Physica*, **7**, 673 (1940).
[5] Clay, J., and Scheen, *Physica*, **14** (viii) (1948).

Preparation of Colloidal Silver-Iodide Water-Suspensions for Nucleation of Supercooled Clouds

In the course of a search for a suitable form in which particles of silver iodide can serve as nucleating agents of a supercooled cloud, Vonnegut tested[1] an aqueous solution of silver iodide (200 gm. of silver iodide and 100 gm. of ammonium iodide in a mixture of 750 c.c. of acetone and 250 c.c. of water). It is reported by him that "solutions can be diluted any desired amount with acetone; dilution with water causes precipitation of AgI". On the other hand, it was known[2] that in experiments on artificially induced rain from supercooled clouds in Algeria, a colloidal aqueous suspension (1 1,000, 1/10 000 by weight) of silver iodide was used with success. Since no particulars of this colloidal aqueous suspension were available, it was decided to try to produce a colloidal suspension (*a*) as stable as possible, (*b*) one that can be diluted to any proportion with water.

The preparation was based on well-known principles: the solubility of crystalline substances, apart from their peculiar behaviour, is a function of the size of the particles. Particles less than 1 μ have a greater solubility than larger ones; moreover, the value of S (solubility) depends upon (*a*) the excess of common ions, (*b*) the concentration of reactive components, and (*c*) the total electrolytic concentration. 0·716 gm. of potassium iodide was dissolved in 140 c.c. of water. While vigorously stirring, a solution of an equivalent amount of silver nitrate (0·734 gm.) dissolved in 80 c.c. water and 20 c.c. acetone was added drop by drop. If the stirring is sufficiently rapid, the rate of addition can be increased. This suspension was then diluted with 760 c.c. water. The silver iodide particles are protected against coagulation by the 'own-ion effect'



and, therefore, the above suspension can be diluted to 1/10,000, or 1/100,000, etc., by adding the requisite amount of water.

An examination of the particles from a 1/100.000 (by weight) suspension (see electron-photomicrograph, scale 1 : 7,000) has shown that the size of the particles is of the order of 0·1 μ in diameter, that is, it is of the same order of magnitude as for particles obtained in the generation of smoke by vaporizing silver iodide[3].

Examination in Tiselius's kataphoresis apparatus demonstrated that the particles are negatively charged, if a solution of silver nitrate is added to the potassium solution, and positively charged if that order is reversed. Having lost their charge to the anode or the cathode respectively, the particles coagulated and fell to the bottom of the vessel. This was accompanied, as a result of action of light, by the breakdown of the molecules into silver and iodine.

The amount of silver iodide precipitated after four weeks was examined analytically and found to be between 5 and 10 per cent.

To test the usefulness of the silver iodide suspension, a domestic refrigerator was used as cold chamber, as suggested by Schaefer[4]. A supercooled cloud was produced by a wet rag, or by breathing into the chamber. A number of sprayers, producing different sizes of droplets, was used in the course of the experiments. In a number of cases the temperature near the bottom of the chamber varied between − 3° and − 20° C. In all these experiments the supercooled cloud turned into an ice-cloud 20–30 sec. after spraying. In some cases crystals were still observable 25 min. after the appearance of the first ice-cloud; but by then the temperature in the chamber rose so high (at the top above 0° C., the room temperature being 29° C.) that the ice crystals soon melted.

As expected, the sign of the charge of the silver iodide particles had no effect.

Suspensions fourteen days old have been tested for efficiency of nucleation. It was found that at a given temperature there is no visible difference between a fourteen-day old and a freshly prepared suspension. In Cwilong's experiments[5], silver iodide particles, evaporated from a platinum wire, showed noticeable ageing. The slow ageing of silver iodide in the water-suspension suggests that this suspension may be economical in use in experiments on cloud seeding, since it can be stored without deterioration for some time.

A detailed report of the results will be published elsewhere. The work was carried out under the auspices of a research committee formed by representatives of the Department of Research (Ministry of Agriculture), the Israeli Meteorological Service (Ministry of Transport and Communications) and the Weizmann Institute of Science, Rehovoth.

E. Katchalsky

Weizmann Institute of Science,
Rehovoth, Israel.

Hava Neumann

Rainfall Research Committee,
Israel.
Sept. 9.

[1] Project Cirrus, Gen. Electric (1948), p. 88.
[2] Ducellier, G., *Agria*, **17**, 223.
[3] Project Cirrus, Gen. Electric (1948), p. 27 and p. 82.
[4] *Chem. Rev.*, **44**, 291 (1949).
[5] *Nature*, **163**, 727 (1949).

Natural Remanent Magnetism of Igneous Rocks and its Mode of Development

The direction of remanent magnetization of igneous rocks has recently been examined in detail[1] in order to investigate the secular variation in the geomagnetic field, and its relation to the problem of the origin of the earth's magnetic field. As was pointed out by the late Prof. J. G. Koenigsberger[2], the occurrence of natural remanent magnetism of igneous rocks is due to a particular magnetic characteristic of the ferro-magnetic minerals, viewed from the physical point of view.

The natural remanent magnetization of rocks, which is fairly intense, can be reproduced only by their cooling in the geomagnetic field from a temperature higher than their Curie point. The temperature-range effective for this magnetic field cooling extends over about 200° below the Curie point, as shown in Fig. 1. The development characteristics of the remanent magnetization caused by cooling in a weak magnetic field can be shown directly by the results of the following experiments.

A rock sample having its Curie point at 585° C. is cooled, for example, from 550° to 500° C. in a weak magnetic field F, and then the magnetic field is removed, with the result that almost the whole

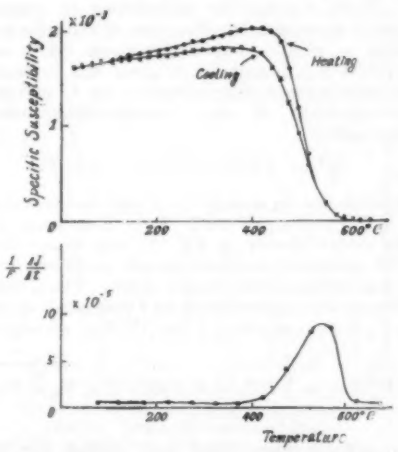


Fig. 1. Change in magnetic susceptibility with temperature (above) and the remanent magnetization produced by partial cooling in a magnetic field at various temperatures. (Sample: augite-bearing olivine-basalt)

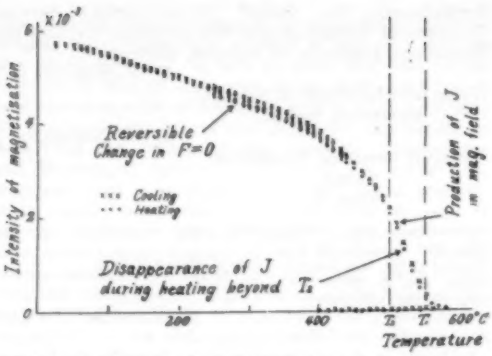


Fig. 2. Development of magnetization by cooling in magnetic field, its reversible change in non-magnetic space, and its disappearance by heating. (Sample: olivine-hypersthene-pyroxene-basaltic andesite)

of the magnetization produced persists as the remanent magnetism. Below 500° C., the remanent magnetization $J(t)$ still increases with decrease in temperature even in non-magnetic space, and $J(t)$ changes reversibly with the change in temperature t, provided that t does not exceed 500° C. and no magnetic field is further applied during any process of cooling. The results of a group of similar experiments show that the nucleus of remanent magnetization in rocks produced by cooling from T_1 to T_2 ($T_1 > T_2$) in a field F always disappears on heating them from T_2 through T_1, regardless of the intensity and direction of magnetic field applied during the heating process.

This law holds even when $T_1 - T_2 = \Delta T = 5°$. We may say, then, that some vectors of magnetic domains in the ferro-magnetic minerals are fixed in the direction of the applied magnetic field during cooling from T_1 to T_2 in the magnetic field F, while they are released in the reverse process. The reversible change of $J(t)$ with temperature below T_2 may correspond to the reversible change in the spontaneous magnetization of domains, well known as the Curie law.

If $\varphi(F,T)$ denotes the probability of orientation of domain vectors in the direction of F during cooling through a small temperature-range ΔT around $T = (T_1 + T_2)/2$, and $I(T,t)$ gives the intensity of their spontaneous magnetization at t, we get for the magnitude of the corresponding remanent magnetization:

$$\Delta J = I(T,t).\varphi(F,T)\Delta T, \quad t < T.$$

Experiments on a number of rock samples indicate that $\varphi(F,T)$ changes with T in a manner similar to the curve shown in Fig. 1, and that values of $\Delta J(T,t)$ produced in a rock sample at different values of T are independent of each other. Then, denoting the remanent magnetization at t produced by cooling from T_1 to T_2 in the field F by $J^{T_2}_{T_1}(F,t)$, we can write:

$$J^{T_2}_{T_1}(F,t) = \int_{T_2}^{T_1} I(T,t)\varphi(F,T)dT, \quad (t < T_2 < T_1),$$

where $\varphi(F,T)$ takes place only during the cooling process and vanishes during the heating process. When F is small ($\lesssim 1$ oersted), it is found that $\varphi(F,T) \simeq F.\psi(T)$. Thus,

$$J^{T_2}_{T_1}(F,t) \simeq F \int_{T_2}^{T_1} I(T,t)\psi(T)dT.$$

The other observed facts that $\varphi(F,T)$ is large in rocks of large coercive force, and that the usual A.C. demagnetizing method (up to a magnetic field 100 times F) can scarcely remove the remanent magnetization produced by cooling in a weak magnetic field, may suggest that $\varphi(F,T)$ is due to a fairly strong internal stress in the ferromagnetic minerals in rocks.

A similar phenomenon has been recently found in the magnetic properties of $CoO.Fe_2O_3$–Fe_3O_4, and those of $TiO_2Fe_2O_3$–Fe_3O_4 are now being examined.

My thanks are due to Mr. H. Manley for a useful discussion.

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Sept. 8.

[1] Bruckshaw, E. McG., and Robertson, E. I., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 308 (1949). Chapman, S., *Nature*, **161**, 462 (1948).

[2] Koenigsberger, J. G., *Terr. Mag.*, **43**, 119 and 299 (1938), and elsewhere.

Partial Ionization in Lithium Hydride

SINGLE-CRYSTAL rotation photographs of lithium hydride (LiH), using copper $K\alpha$ radiation, show clearly that the structure is of a sodium chloride type, but that the lithium and hydrogen atoms are by no means completely ionized. Atomic scattering curves have been drawn from the corrected intensity data for the 'all even' reflexions (Li + H); and for the 'all odd' reflexions (Li−H). From these the separate atomic scattering curves for the Li^{+z} ion and for the H^{-z} ion (uncorrected for temperature scattering) have been deduced. The thermal scattering, which is of the same order as that in sodium chloride (though differently distributed), has also been studied separately by means of 'diffuse' Laue photographs. The results show that the most probable state of ionization is $Li^{+0.25}$, $H^{-0.25}$. The absolute limits that could be supposed to agree with the observations would be 50 per cent ionic character or, at the opposite extreme, complete covalency.

I am indebted to Prof. Kathleen Lonsdale for help and advice in this research, which will be published more fully later.

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London.
Nov. 11.

Action of Phenolic Substances on the Blood-clotting Effect of *Bothrops atrox* Venom

Gerber and Blanchard[1] reported the accelerating effect of different phenols on blood clotting. Laki *et al.*[2] have also found that catechol added to thrombin shortens the coagulation time of plasma.

During a series of experiments which were carried out for the purpose of comparing the blood-clotting effect of *Bothrops atrox* venom and thrombin, the action of certain phenolic substances on the coagulation has also been investigated. The differences between the two coagulating principles have been

CLOTTING TIMES OF PLASMA AND FIBRINOGEN IN SECONDS IN PRESENCE OF DIFFERENT PHENOLIC SUBSTANCES OR SALINE

Added substance		Phenol		o-Cresol		Resorcinol		Catechol		Saline
Final concentration in the test in %		0·25	0·50	0·25	0·50	0·25	0·50	0·25	0·50	
Thrombin	Plasma	32	18	21	18	23	15	36	17	78
	Fibrinogen	67	45	—	—	53	40	78	50	143
Venom	Plasma	63	44	45	44	40	31	47	35	106
	Fibrinogen	80	46	—	—	54	37	67	45	160

reported elsewhere[3,4]. In the present work it is found that phenolic substances have the same effect on the two clotting agents.

In the experimental work, solutions of phenolic substances were used in such dilution that their final concentration was 0·25–0·5 per cent. Their action was tested on oxalated horse plasma and fibrinogen, which were buffered with phosphate to 6·8 *p*H. The clotting times were compared with the time obtained when, instead of the phenolic substance, physiological saline was used. The results (see table) show that the phenolic substances accelerate the clotting of plasma or fibrinogen when either thrombin or *Bothrops atrox* venom are used as a clotting agent.

As an explanation of the potentiation of the thrombin fibrinogen interaction by phenols[1], the view has been put forward that blood clotting is an oxidation-reduction process which can only operate through the oxidation of susceptible SH-groups of fibrinogen by thrombin, and that this oxidation can be accelerated by the reversible oxidation-reduction of active phenols, taking the role of hydrogen carriers. Other workers[5] have denied the presence of susceptible SH-groups in fibrinogen, claiming that fibrinogen clotted normally after treatment with oxidizing agents strong enough to oxidize the sulphhydryl groups. Even though Laki and Mihályi[6] offer new possibilities for the explanation of the thrombin–fibrinogen interaction, no final explanation can yet be given of the fact that the phenolic substances do accelerate the coagulation induced by thrombin as well as by *Bothrops atrox* venom. A detailed account of the experiments above will appear elsewhere.

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Sept. 1.

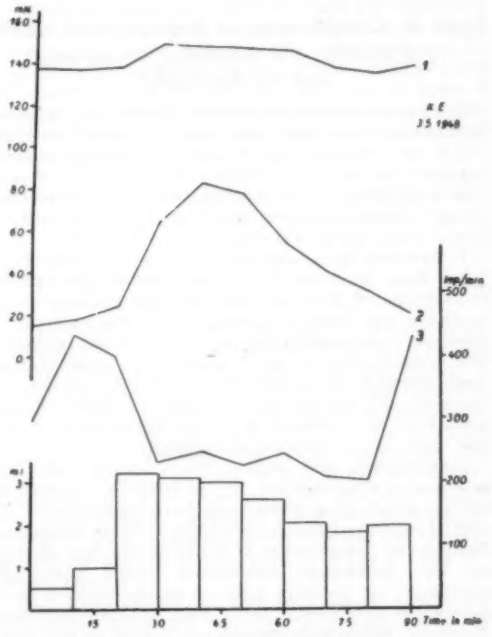
[1] Gerber, C. F., and Blanchard, E. W., *Amer. J. Physiol.*, **144**, 447 (1945).
[2] Laki, K. (unpublished data).
[3] Jánszky, B., *Science* (In the press).
[4] Jánszky, B., *An. Inst. Pinheiros*, **12**, 113 (1949).
[5] Bagdy, Guba, Loránd and Mihályi, *Hung. Acta Physiol.*, **1**, 197 (1948).
[6] Laki, K., and Mihályi, E., *Nature*, **163**, 66 (1949).

Anion Excretion by the Gastric Mucosa

CHLORIDE, bromide, iodide and thiocyanate ions have physicochemically and pharmacologically different properties. They also show different behaviour in diffusion, in affecting various tissues, in excretion by urine, in passage to the lymph, etc. These four ions have an important common quality: all have the same negative charge. In plasma, bromide, iodide and thiocyanate can replace chloride. If, for example, we increase the bromide concentration in plasma, there will, as has been shown by many investigators, be a change in the ratio bromide/chloride, but the total halide concentration remains constant.

Davenport[1,2] has examined the relations bromide/chloride and iodide/chloride in plasma and in gastric juice; he states that bromide and iodide can replace chloride in plasma and also in gastric juice. We have not laid particular stress upon the relation between the plasma content of bromides, iodides and thiocyanates, and the gastric concentrations of these ions. We examined instead the relative concentrations of the ions as contributing to the variations in the acidity of the gastric juice[3].

The excretion of bromide was studied by means of radiobromine in cats and patients. The accompanying figure shows the excretion of radiobromide in a patient after injection of histamine. The excretion of iodide in dogs and patients was studied separately by Lagergréen[4]. Thiocyanate is excreted spontaneously; but we know already from Pavlov's investigation on thiocyanate that this anion is a normal constituent of the gastric juice. Iodide was given orally the day before the experiment.



Curve 1. Total chloride content (millinormality).
Curve 2. Total acidity (millinormality).
Curve 3. Radioactivity measured in 1 ml. gastric juice.
Below, the volumes of the single fractions of gastric juice, given in ml.
Radiobromine, in a physiological salt solution, was administered intravenously (700,000 counts/min.) 2 hr. before the injection of histamine

From these investigations we have reached the following conclusions. (1) The proportion of bromide, iodide and thiocyanate in the gastric juice is higher than that in the plasma. (2) The relative concentration of these three anions in the gastric juice diminishes when the rate of secretion and the acidity increase. At the end of the effect of the histamine, the concentration of the above-mentioned ions increases simultaneously with decreasing acidity. (3) These anions replace chloride, but only neutral chloride occurring in the gastric juice. Thus, if the bromide or iodide concentration in the blood increases, the total halide concentration remains unchanged in the gastric juice. The excretion mechanism of these ions is probably the same as that of neutral chloride.

A detailed report on the different investigations on these ions and the mutual relation between the ions will be published later. This work was carried out with the aid of a grant from Wallenbergs Foundation.

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Surgical Service II
and Medical Service I,
Göteborg.
Sept. 15.

[1] Davenport, H. W., and Fisher, R. B., *Amer. J. Physiol.*, **131**, 165 (1940).
[2] Davenport, H. W., *Gastroenterology*, **1**, 1055 (1943).
[3] Gabrieli, E., *Acta Physiol. Scand.* (1948) (abstract of communication to the Sixth Scandinavian Physiological Congress).
[4] Lagergréen, B. (in the press).

Lysis by Complement of Erythrocytes which have adsorbed a Bacterial Component and its Antibody

POLYSACCHARIDE components of many pathogenic bacteria are adsorbed from solution to erythrocytes, which then become agglutinable by sera containing antibody for the appropriate polysaccharide. A protein constituent of *Hæmophilus pertussis*, and some closely related bacteria, itself agglutinates erythrocytes which have adsorbed it[1].

It has now been observed that erythrocytes which have first adsorbed a polysaccharide or protein constituent of bacteria, and then the corresponding antibody, are lysed by complement. The mechanism involved is presumably similar to that of bacteriolysis. The phenomenon is well adapted to quantitative measurements of a bacterial antibody, because of the ease with which hæmolysis can be observed and measured, and because a known component of the bacterial cell is used in the system.

Middlebrook and Dubos[2] have shown that the presence of antibody for *M. tuberculosis* is indicated by the ability of a serum to agglutinate erythrocytes coated with a polysaccharide fraction of the organism. During the examination of a number of bovine sera by this technique, anomalous results were encountered, at variance with those anticipated from tuberculin sensitivity tests, and autopsy findings. However, when complement was added to the mixtures of sera and sensitized cells, hæmolysis occurred in those tubes in which sera of tuberculous or vaccinated cattle were present, but not in those containing the sera of unvaccinated normal animals, irrespective of the prior presence or absence of hæmagglutination.

Assay of neutralizing antibody for pertussis hæmagglutinin is complicated by the fact that samples of serum vary in their content of a non-specific neutralizing substance, which is probably identical with the lipid receptor for pertussis hæmagglutinin of the erythrocyte surface[3,4]. If, however, antibody for pertussis hæmagglutinin is assayed in terms of its capacity to sensitize to lysis by comp'ement erythrocytes which have first been coated with hæmagglutinin, this complication is avoided.

Most varieties of erythrocytes in common use in the laboratory are susceptible to lysis by this mechanism; sheep cells are sensitive and suitable. Sheep cell lysins must first be removed from the sera under test, and from the guinea pig serum used as a source of complement.

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E. V. KEOGH

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Victoria.

[1] Keogh, E. V., North, E. A., and Warburton, M. F., *Nature*, **160**, 61 (1947); **161**, 687 (1948).
[2] Middlebrook, G., and Dubos, R. J., *J. Exper. Med.*, **88**, 521 (1948).
[3] Keogh, E. V., unpublished observations.
[4] Fisher, S., *Brit. J. Exper. Path.*, **29**, 357 (1948); and awaiting publication.

'Whiptail' in Cauliflower

SINCE 1939, several workers[1,2] have shown that molybdenum is an essential element for crop plants, and in 1945 it was suggested by Davies[3] in New Zealand that a deficiency of this element was responsible for the condition in brassicas known as 'whiptail'.

'Whiptail' of cauliflowers and broccoli, characterized by severe restriction of the leaf lamina, death of the growing point and chlorosis, is endemic in south-eastern England, more especially on soils derived from the Hastings Beds, and occasionally severe losses are experienced. The trouble appears to be worst in dry seasons, and usually but not invariably occurs on acid or slightly acid soils; in such cases a dressing of lime often effects a partial or complete cure.

Following chemical evidence obtained in 1947 that 'whiptail' might be caused by low molybdenum status, field-trials were laid down in 1948 and 1949 to test the effects of a molybdenum salt and of lime on this disease. The 1948 trial proved unsuccessful due to the non-appearance of the trouble. The 1949 trial was carried out on a slightly acid (*p*H 6·0) soil derived from the Tunbridge Wells Sandstone and on a field where 'whiptail' had caused considerable losses in past years. Four replicated treatments were given, and the details of these treatments as well as the percentages of affected plants when the crop was nearing maturity are as follow:

1.	Control	69 per cent affected with 'Whiptail'
2.	Ground chalk at 2 tons per acre	31 " " " "
3.	Chalk plus sodium molybdate at 10 lb. per acre	12 " " " " "
4.	Sodium molybdate at 10 lb. per acre	18 " " " " "

In this trial, therefore, it will be seen that liming has effected some improvement, while sodium molybdate has markedly reduced the percentage of affected plants.

Observations made during the course of these investigations, however, may suggest that in certain cases 'whiptail' may be due to cultural causes rather than to molybdenum deficiency.

Confirmatory evidence has also been obtained for the recent suggestion by Nicholas[4] that there is a strong inter-relationship between manganese and molybdenum in cases of 'whiptail'.

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W. Dermott

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National Agricultural Advisory Service,
Wye, Ashford, Kent.
Sept. 26.

[1] Arnon, D. I., and Stout, P. R., *Plant Physiol.*, **14**, 599 (1939).
[2] Piper, C. S., *J. Aust. Inst. Agric. Sci.*, **6**, 162 (1940).
[3] Davies, E. B., *Nature*, **156**, 392 (1945).
[4] Hewitt, E. J., Jones, E. W., and Nicholas, D. J. D., Ann. Rep. Long Ashton Res. Stn., 79 (1947).

Aeration of Culture Media

In biological work, oxygen has often to be supplied to an organism by bubbling air, or some other oxygen-containing gas, through the culture medium. The rate at which oxygen is available for consumption by the organism is frequently limited by the rate at which oxygen dissolves from the gas phase. Although this has been realized[1], there has been little attention given to this point in the literature. An easy method of assessing the effect of aeration has been developed, using a polarograph to measure the concentration of dissolved oxygen[2].

It is well known[3] that the rate of solution of oxygen in a liquid can be expressed by an equation:

$$\frac{dC}{dt} = \varphi_L (C_s - C), \qquad (1)$$

where φ_L is a constant with respect to C and t, C is the concentration of dissolved oxygen at time t, and C_s is the concentration of dissolved oxygen when the solution is saturated with oxygen at a given partial pressure of oxygen in the gas phase. From equation (1) the maximum rate at which oxygen dissolves is given by $\varphi_L C_s$. The value of $\varphi_L C_s$ can be determined in two ways:

(i) The vessel is filled with a solution of potassium chloride or a fermented medium with the oxygen demand inhibited. The dissolved oxygen is then removed by gassing out with nitrogen. Aeration is started at a given time, and thereafter samples are removed at known times and the concentration of dissolved oxygen determined polarographically. The value of $\varphi_L C_s$ can be obtained from these results by using the integrated form of equation (1).

(ii) In an aerated medium containing an organism with a zero-order oxygen demand, k_s, the concentration of dissolved oxygen will be maintained at a steady concentration C_s if $\varphi_L C_s > k_s$. It is easily shown that

$$\varphi_L = \frac{k_s}{C_s - C_s'} \qquad (2)$$

C_s' is obtained by placing a sample from the fermentation vessel in the polarographic cell and measuring the concentration of dissolved oxygen against time. The plot of this is linear, with a slope k_s. It is extrapolated to the time when the sample was taken, to give the value of C_s'. C_s is obtained by saturating the sample with air in the polarographic cell, and if necessary another determination of k_s can then be made.

Values of $\varphi_L C_s$ have been determined for a number of vessels, with more than a thousand-fold variation in capacity, in which penicillin and streptomycin fermentations have been carried out. It was found that φ_L depended on the size and shape of the vessel, but was directly proportional to the rate of air-flow. φ_L was greatly increased by stirring. It was also found that when $\varphi_L C_s$ was greater than the peak oxygen demand of an adequately aerated fermentation, the titre of antibiotic produced became independent of $\varphi_L C_s$. Below this limiting value of $\varphi_L C_s$, the titre fell off quickly and reached zero at a value of $\varphi_L C_s$ approximately equal to $k_s/2$. No effect of stirring was found, apart from the increase in φ_L.

A full account of this work will be published elsewhere. I am indebted to the directors of the Distillers Company, Ltd., for permission to publish this work.

W. S. Wise

Distillers Company, Ltd.,
Great Burgh,
Epsom.
Sept. 6.

[1] Olson and Johnson, *J. Bact.*, **57**, 235 (1949).
[2] Petering and Daniels, *J. Amer. Chem. Soc.*, **60**, 2796 (1938).
[3] Sherwood, T. K., "Absorption and Extraction", 64 (McGraw-Hill, 1937).

A New Type of Pipette for Radioactive Solutions

Ordinary pipettes cannot be used for measuring volumes of radioactive solutions, since it is highly dangerous to get a radioactive substance in the mouth. Many different pipettes have been designed to overcome this sort of difficulty[1]; but the type of pipette described below possesses advantages over existing types in simplicity of construction and ease of operation.

A side-arm about one inch long is sealed on an ordinary 1-ml. calibrated pipette, and a small rubber bulb is placed on the side-arm. With the finger on the top, the bulb can be used to draw liquid into the pipette, which can then be used in the ordinary way. For larger capacity pipettes (say, 10 ml.) it is still possible to use a small bulb, since when liquid has been drawn into the pipette the finger can be released and the bulb pressed, whereupon more liquid can be drawn up by replacing the finger and releasing the bulb. This operation can be carried out quickly enough for only a small amount of liquid to run out of the pipette.

This type of pipette has been found useful for radioactive solutions, and may find application for other poisonous or unpleasant liquids.

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University,
Edgbaston, Birmingham 15.
Nov. 1.

[1] Rheinfels, *Chem. Tech.*, **16**, 146 (1943).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 13

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. M. Hartog: "Oxford Expedition to the Arctic".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Interference Suppression" (to be opened by Mr. E. M. Lee).

INSTITUTION OF THE RUBBER INDUSTRY, MIDLAND BRANCH (at the James Watt Institute, Great Charles Street, Birmingham), at 7 p.m.—Mr. J. M. Buist: "Abrasion Resistance and its Measurement".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8 p.m.—Dr. W. F. Libby: "The Carbon-14 Method of Dating".

Tuesday, February 14

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Philip Mayer: "Privileged Obstruction of Marriage Rites among the Gusii".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Conference on "Formation and Properties of Gas Bubbles".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. W. P. Mansfield: "Equipment and Experimental Methods used in the Study of Internal Combustion Engines".*

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. David L. Linton: "Landform Studies in the Cairngorm Mountains".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. K. W. Pepper: "Recent Developments in Ion-Exchange Resins".

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the College of Technology, The Newarke, Leicester), at 7 p.m.—Mr. J. W. Hendry: "Time Study as an Aid to Productivity".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Dr. N. J. Petch: "Griffith Cracks".

ROYAL STATISTICAL SOCIETY, TEES-SIDE SUB-GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the William Norton School, Norton), at 7.15 p.m.—Mr. L. T. Wilkins: "Man-Machine Relationships (Some Studies in Flying Safety)". (To be repeated at 6.30 p.m. at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne, on Wednesday, February 15.)

Wednesday, February 15

PHYSICAL SOCIETY, COLOUR GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—General Discussion on "Colour Systems" (to be opened by Mr. R. G. Horner).

UNIVERSITY OF LONDON (in the Wright-Fleming Institute Theatre, St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. Z. M. Bacq (Liège): "The Metabolism of Adrenaline" (Belgian Interchange Lecture).*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. Millington and Mr. G. A. Isted: "Ground-Wave Propagation over an Inhomogeneous Smooth Earth—Experimental Evidence and Practical Implications".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE AND NORTH-EAST COAST SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "The Constitution of Drying Oil Glycerides".

INSTITUTION OF ELECTRICAL ENGINEERS, MAIDSTONE DISTRICT (at the New Inn, Sandling Road, Maidstone), at 7.30 p.m.—Mr. J. T. Hazel: "An Historical Survey of the Development of Electric Cables".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (in the Reynolds Hall, College of Technology, Manchester), at 7.30 p.m.—Mr. J. Blears: "The Mass Spectrometer".

Thursday, February 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "The Use and Abuse of Statistics".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Discussion on "The Mode of Action of Local Hormones" (to be opened by Prof. J. H. Burns, F.R.S.).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P. F. Holt: "The Determination of the Mass Concentration of Air-borne Dusts—an Apparatus for the Sublimation of Volatile Filter Bases"; Dr. J. S. Webb and Mr. A. P. Millman: "Heavy Metals in Natural Waters as a Guide to Ore—a Preliminary Investigation in West Africa"; Mr. G. F. Mortimer: "Grade Control".

LONDON MATHEMATICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. B. L. van der Waerden: "Birational Invariants".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Small Physics Lecture Room, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. R. S. Dadson: "Determination of the Threshold of Hearing".

CHEMICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7.15 p.m.—Prof. J. W. Cook, F.R.S.: "Polycyclic Aromatic Hydrocarbons" (Pedler Lecture). (To be repeated on Thursday, March 9, in the Chemistry Department, The University, Manchester, at 6.30 p.m.)

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Dr. James Taylor: "Applications of Exothermic Solid Reactions to Jet Propulsion and Industrial Purposes".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Joseph E. Smadel (Washington, D.C.): "Chloramphenicol (Chloromycetin) and Tropical Medicine".

Friday, February 17

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Dr. A. S. Parkes, F.R.S.: "The Primrose Path, some Aspects of the Population Problem" (Galton Lecture).

UNIVERSITY OF LONDON (in the Wright-Fleming Institute Theatre, St. Mary's Hospital Medical School, Paddington, London, W.2), at 5 p.m.—Prof. Z. M. Bacq: "The Potentiation of Biological Responses by Potassium Ions" (Belgian Interchange Lecture).*

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. F. A. Vick: "Musical Acoustics".

Saturday, February 18

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at Holly Royde, 30 Palatine Road, Withington, Manchester), at 2.45 p.m.—Mr. A. K. Cairncross: "Some Problems of Planning".

INSTITUTION OF OFFICE MANAGERS, SHEFFIELD BRANCH (joint meeting with LOCAL STUDIES GROUP, at the Royal Victoria Station Hotel, Sheffield), at 3 p.m.—Mr. J. C. W. Stead: "Education for Management".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Dr. J. C. Flugel: "Tolerance" (Chairman's Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURERS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Queen's University, Belfast (February 20).

EXAMINERS IN CHEMISTRY AND PHYSICS, BIOLOGY (BOTANY AND ZOOLOGY), PHYSIOLOGY (including BIOCHEMISTRY) OF THE DOMESTICATED ANIMAL, HISTOLOGY AND EMBRYOLOGY, ANIMAL MANAGEMENT, ANATOMY OF THE DOMESTICATED ANIMALS, PHARMACOLOGY, MATERIA MEDICA AND PHARMACY, VETERINARY HYGIENE, DIETETICS AND ANIMAL HUSBANDRY, VETERINARY PATHOLOGY, VETERINARY PARASITOLOGY, VETERINARY MEDICINE, VETERINARY SURGERY—The Registrar, Royal College of Veterinary Surgeons, 9 Red Lion Square, London, W.C.1 (February 20).

REGISTRAR AND SECRETARY—The Chairman, Professional Engineers Appointments Bureau, 9 Victoria Street, London, S.W.1 (February 20).

RESIDENT LECTURER (woman) IN PHYSIOLOGY, ANATOMY, PATHOLOGY OR BIOCHEMISTRY—The Principal, Newnham College, Cambridge (February 28).

COW AND GATE FELLOWSHIP for research into problems associated with nutrition in infants and children—The Registrar, The University, Manchester 13 (March 3).

HEAD OF THE CHEMISTRY DEPARTMENT, a HEAD OF THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT, and a HEAD OF THE PHYSICS DEPARTMENT—The Clerk to Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (March 3).

LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary and Registrar, University College of North Wales, Bangor (March 4).

RESEARCH OFFICER (Ref. No. 2346) IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne, to carry out investigations on the application of mass spectroscopy to physico-chemical problems, and a RESEARCH OFFICER (Ref. No. 2584) IN THE BUILDING RESEARCH LABORATORY, Melbourne, to develop equipment for measuring stress and strain and to apply these to problems of stress analysis associated with building materials and structures—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 4).

SENIOR PHYSICIST at the Cancer Institute, Melbourne—The Manager and Secretary, Cancer Institute Board, 483 Little Collins Street, Melbourne, Victoria, Australia (April 6).

CHAIR OF PHYSICS, and the MACARTHY CHAIR OF ECONOMICS, at the Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

CHAIR OF PURE MATHEMATICS—The Registrar, The University, Nottingham.

JUNIOR PHYSICAL CHEMIST in the Chester Beatty Research Institute, to work on proteins (by electrophoresis and diffusion methods, etc.)—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.

LECTURER IN METALLURGY—The Registrar, Central Technical College, Suffolk Street, Birmingham 1.

SENIOR CROP RECORDER, a CROP RECORDER, and a JUNIOR ASSISTANT FOR POTATO INVESTIGATIONS—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

STUDENTSHIPS for postgraduate training in PLANT BREEDING, PLANT PHYSIOLOGY, and ENTOMOLOGY—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.